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Item 546-D GAO/13:LCD-81-7

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

COMPLETED ORIGINAL

Agencies Should Encourage Greater Computer Use On Federal Design Projects

The use of computer-aided methods on Federal design projects is often limited or hampered by agency officials and agency procedures and practices. While significant benefits and savings are possible through computer aids, this capability is not always being used.

Changes in some procurement procedures should create an environment more conducive to greater, more efficient use of computer-aided methods. These changes should include (1) educating agency personnel about the capabilities and uses of computers in design, (2) requiring that computers be used for those analyses and design functions which can be done efficiently only with computers, (3) evaluating computer expertise when selecting architects and engineers for Federal projects, (4) discussing planned computer use during negotiations, and (5) revising fee proposal formats to recognize the role of computers in design and to clearly identify the services which will be provided under the contract.

LCD-81-7
OCTOBER 15, 1980

(10)

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-200100

To the President of the Senate and the
Speaker of the House of Representatives

This report describes some of the problems architect-engineer firms have experienced when using or attempting to use computer aids on their Federal design contracts. It suggests ways to improve the procurement of architect-engineer services and to eliminate or minimize many of the problems we identify.

Copies of this report are being sent to all Federal departments and agencies procuring architect-engineer services and to officials of professional societies and private firms which participated in the review.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

AGENCIES SHOULD ENCOURAGE GREATER COMPUTER USE ON FEDERAL DESIGN PROJECTS

D I G E S T

Federal agencies are not actively seeking or encouraging the use of computers on Federal design projects. As a result, they are missing opportunities to achieve significant savings and improve the quality of Federal building designs.

Federal officials and agency procedures and practices often limit and/or hamper the use of computers on Federal projects. Agencies generally have not created an environment wherein the efficient use of computers is possible. Fee proposal forms used by most Federal agencies in acquiring architect-engineer services do not recognize the possible use of computers or provide a place for computer service costs to be included as direct costs in proposals. During contract negotiations, agency personnel rarely discuss the planned use of computers on a project. Even during the architect-engineer selection process, most agencies ignore computer capability.

BENEFITS OF COMPUTER AIDS IN DESIGN

In comparison to manual methods, computers can enable designers to produce higher quality, more effective facility planning and architectural designs; reduce the amount of energy consumed by buildings; and lower overall building costs through reduced construction, maintenance, and operating costs. In short, they enable the designer to consider more alternatives and do many things which are impossible using manual methods. (See ch. 2.)

LCD-81-7

Tear Sheet. Upon removal, the report cover date should be noted hereon.

GAO's survey of architectural and engineering firms indicates that the number of firms having computer capability or access to computer services is sufficient to provide adequate competition should agencies actively seek computer expertise for Federal projects. Details on the results of GAO's questionnaire survey are contained in a separate staff study (LCD-81-2).

COMPUTER USE NOT ENCOURAGED

Federal agencies have not created an environment which promotes or supports the efficient use of computer-aided design methods. Agency officials, sometimes unknowingly, limit computer use by (1) their general lack of understanding about computer-aided design methods and the related costs and (2) their restrictive procedures and actions in contract negotiations and project management. (See ch. 3.)

FEE PROPOSAL FORMATS IGNORE COMPUTER USE

All but one of the fee proposal formats Federal agencies use ignore computer-aided methods. Only a few formats clearly show the services to be provided. Also, formats lack uniformity, which creates confusion among architect-engineer firms doing work for more than one agency.

Revising the formats and redirecting the emphasis of the proposal from prescriptive ("who will do the work") to performance ("what work will be done") will insure all parties to the agreement clearly understand what work the fee will cover. It will also give negotiators the information they need to determine whether the proposed fee is fair and reasonable. Preprinted forms, which most agencies use, cause proposals to be tailored to the form instead of to the project. GAO believes revising the proposal formats and eliminating the existing preprinted forms to permit architect-engineer firms to submit fee proposals in a prescribed format, but

on the firms' own stationery, will provide a better tool for negotiating contracts. (See ch. 4.)

NEGOTIATIONS OVERLOOK COMPUTER USE

Federal agencies have generally ignored the evolution of the computer as a major design tool when negotiating architect-engineer services contracts. Negotiators do not necessarily insure that the architect-engineer firm has a clear understanding of the project requirements or that a fair and reasonable price is negotiated when computer-aided methods are used. (See ch. 5.)

COMPUTER EXPERTISE NOT A SELECTION FACTOR

Federal policy requires that architects and engineers be selected on the basis of their demonstrated competence and qualifications to do the work. Agencies are starting to require computer-based analyses, such as energy analyses. Still, few agencies consider and evaluate computer expertise when selecting an architect-engineer firm for a project. (See ch. 6.)

RECOMMENDATIONS

GAO recommends that the heads of departments and agencies procuring architect-engineer services take the following actions:

--Provide appropriate training on the capabilities and uses of computers in design to their employees. Also, encourage employees to stay current on new and improved uses of computers in their individual areas of expertise.

--Provide sufficient technical support to contract negotiating teams.

--Direct that computer use be required for those analyses and design functions which can be efficiently done only by computer-aided methods. Also, encourage computer use in all areas where the quality of the

design or the structure to be built can be improved when computer aids are used.

--Require computer capabilities and expertise to be considered and evaluated when selecting architects and engineers for projects on which computer-aided methods, such as in energy analyses, can be used. Also, revise the criteria used in evaluating overall qualifications of firms for design contracts to include computer capability and expertise.

--Require that architect-engineer contract negotiators routinely discuss and evaluate planned use of computers when negotiating design contracts.

GAO recommends that the Administrator, Office of Federal Procurement Policy, with the concurrence of the Director, Office of Management and Budget, promulgate an architect-engineer procurement policy which establishes that:

--Fee negotiations will be based on proposals which clearly identify tasks which will be performed by firms providing architect-engineer services, and, when applicable, indicate how computers will be used on the project.

--Procedures in pricing computer services will be flexible as long as the method used is the same as the firm uses for all its clients, both public and private, and conforms with existing Federal Procurement Regulations.

--A structured task-oriented fee proposal format will be developed and the use of preprinted fee proposal forms will be discontinued, permitting architect-engineers to submit their fee proposals in the prescribed structured format on their own stationery.

GAO also recommends that the Administrator require the Department of Defense and the General Services Administration to implement

the new policy by revising the Defense Acquisition Regulations and the Federal Procurement Regulations, respectively; and jointly ensuring that this policy is incorporated into the new Federal Acquisition Regulations currently being developed.

Further, GAO recommends that the Executive Secretary, Federal Construction Council, Building Research Advisory Board, direct the Council to develop educational programs and sponsor conferences aimed at educating Federal personnel about computer capabilities and uses in design. (See ch. 7.)

AGENCY COMMENTS

The 11 agencies commenting on the draft report generally agree, in principle, with the findings, conclusions, and recommendations presented in this report. However, some agencies disagree with three of the recommendations.

The General Services Administration and the U.S. Postal Service oppose requiring computer use for those analyses which can be efficiently done only by computer-aided methods. Both believe GAO is recommending wholesale use of computers without regard for the benefits which can reasonably be expected to be realized. Their interpretation is rather broad and inconsistent with the intent of the recommendation. Neither agency appears to be considering the full economic benefits offered by computers.

In addition, the General Services Administration opposes making computer capability and expertise a factor in selecting design firms. It believes this would discriminate against small firms because these firms do not have available the necessary computer capabilities. The results of the questionnaire survey show that computer capability is available to all firms regardless of size.

The U.S. Postal Service and the Veterans Administration oppose eliminating the preprinted fee proposal forms currently used by most agencies. Both agencies feel the form is essential for making it easier to compare the design firm's fee proposal and the Government's estimate and to facilitate the preaward audit, when required. GAO believes that the preprinted form is unnecessary and that a prescribed, structured fee proposal format will satisfy the U.S. Postal Service's and Veterans Administration's concerns. Several agencies already use the recommended procedures without any problems. (See ch. 8.)

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CHAPTER 1

PERSPECTIVE

This is our second report on the use of computers in building design. The first report, a staff study entitled "Computer-Aided Building Design" (LCD-78-300, July 11, 1978), concentrated on the state of the art and identified factors inhibiting the further development and use of computer technology in building design. In this report, we discuss the problems architect-engineer firms experience when using or attempting to use computer aids on Federal design work. We make several recommendations aimed at improving the process for obtaining architect-engineer services and increasing the use of currently available computer methods on Federal projects.

We undertook this review because of claims that Government policies and procedures inhibit the use of computers on Federal building design projects. Our July 1978 computer-aided building design staff study shows that computer-aided methods offer broad potential for improving building designs, lowering building operating costs, and, in some instances, lowering construction costs, as well as improving the performance of the building's systems and reducing the risk of failure of these systems. We believe that greater computer use can lead to better designs because, among other things, computers allow more design alternatives and more accurate analysis approaches to be considered quickly.

It was the intent of the sponsors of Public Law 92-582 (amending the Federal Property and Administrative Services Act of 1949) that the highest qualified architectural and engineering firms be hired for Federal projects. They recognized that failure for any reason to obtain the highest quality plans and specifications may result in higher construction costs, a functionally inferior structure, or troublesome maintenance problems. Our staff study indicated that agencies may not always be obtaining the highest possible quality design because of restraints they place on design firms. During this prior study, architects and engineers told us they were often frustrated in their attempts to use computer aids on Federal work because of agency procedures, Federal officials' viewpoints toward computers, and the way computer costs were treated in fee negotiations. As this report shows, these problems still exist.

The Federal Government, as a building owner, stands to benefit a great deal from effectively using computer aids on its projects. Computers can help building designers produce higher quality, lower life-cycle cost buildings, which consume less energy and respond better to user needs. These are objectives which each Federal agency is or should be trying to achieve. Each agency has a vested interest in the creation of its buildings and other structures. Each should be striving to create an environment which promotes and supports the efficient use of modern design methods, including computer aids. This environment needs to be created if the benefits computer aids offer are to be realized.

Under existing Federal policies and regulations, agencies are able to procure the architect-engineer services they need. Yet agencies are continually experiencing higher construction costs than anticipated and troublesome maintenance problems, and some new facilities are not adequately fulfilling users' functional needs. We do not want to imply that all of these problems are the designer's fault, but we feel that design deficiencies are one of the contributing causes for many of these problems, and therefore, are cause for concern. We believe that these problems indicate, at least for those problems directly or indirectly attributable to design, that the full intent of the Federal policy has not yet been achieved and that policies, procedures, and practices for procuring architect-engineer services need improving.

OBJECTIVES, SCOPE, AND METHODOLOGY

Our review was aimed at ascertaining Federal officials' points of view on the use and benefits of computer aids and identifying problems design firms experience using computers on Federal work. We wanted to know whether Federal attitudes, policies, and practices inhibit or discourage the use of computer methods. We also sought viable alternatives or methods which would promote and support the efficient use of modern design methods on Federal work.

Contracting procedures are essentially the same for all types of architect-engineer services, and agencies usually use the same fee proposal forms for contract negotiations, without regard to the type of services to be performed. Therefore, we realized that, although our primary concern was the use of computers in building design, any recommendations resulting from this review would affect all types of architect-engineer contracts involving the use of computer-aided methods and would have much broader application

than just building design. Consequently, our review was intentionally broad based and not limited to just building design contracts.

In a March 1979 report to the Office of Federal Procurement Policy, the General Services Administration identified 47 major organizational components of 19 Federal agencies which procure architect-engineer services. These organizations awarded 3,838 architect-engineer contracts totaling $371.8 million during fiscal year 1976. Since it was not feasible to include all 47 organizations, we limited our review to 11 agencies which would provide us with adequate coverage for agencies of various sizes and for the different types of structures designed and built by the Government. Still, the recommendations made in chapter 7 apply to all 47 organizations. In fact, some of the comments made by architects and engineers contacted were directed at agencies not included in the review.

We used the number of architect-engineer contracts awarded by an agency as a criterion for agency size; selecting the Corps of Engineers and the Naval Facilities Engineering Command as large agencies, the National Aeronautics and Space Administration and the National Park Service as medium size agencies, and the Department of State and the U.S. Coast Guard as small agencies. We then added the Veterans Administration; the Department of Health, Education, and Welfare (now the Department of Health and Human Services); the Department of Energy; the General Services Administration; and the U.S. Postal Service to cover the variety of structures constructed by the Federal Government. A complete list of the agencies and field offices included in the review is provided in appendix I.

Our review also included substantial input from the private sector. Using records of the above-mentioned agencies, we identified 800 firms which had performed architect-engineer services for the Government between January 1976 and November 1978. The contracts, which were awarded to these firms, included all types of projects--from buildings, to piers, to flood insurance studies. We sent these 800 firms a questionnaire we developed to obtain preliminary information about the use of computers by design firms in general and about computer use on specific Federal projects. Seven hundred and fifty firms (93.8 percent) responded. Five of these responses were received too late to be considered in our statistical analysis, therefore, the statistics in the report are based on 745 responses. The results of the questionnaire survey are being issued in a separate staff study (LCD-81-2, 1980).

The firms selected were those for which we could locate a current mailing address. They do not represent a true statistically based sample; therefore, caution should be used in interpreting and using the results of the architect-engineer survey. Statistical results represent only the responding firms and should not be projected to the total number of firms working for the Government.

We visited 56 firms and obtained more detailed information on their experience dealing with Federal agencies on projects involving computers. Three of these firms were not included in our questionnaire survey, but some of the other firms we visited suggested that these three firms might have something to contribute to our review. Another firm was included in the survey, but did not respond. We visited this firm anyway because we were aware that it had experienced some difficulties negotiating computer services on a contract with one of the agencies we reviewed. We telephoned 28 additional firms because their questionnaire responses raised questions we wanted to resolve.

After completing our fieldwork, we discussed our observations with representatives of the Federal Construction Council, the National Institute of Building Sciences, the Committee on Federal Procurement of Architectural/Engineering Services, and The American Institute of Architects. We also discussed our observations, conclusions, and recommendations with each of the 11 agencies reviewed and the Office of Federal Procurement Policy.

PRIOR REPORTS AND STUDIES

During the last 3 years, we have issued 23 reports and staff studies on matters relating to design and construction activities. These are listed in appendix II.

CHAPTER 2

SIGNIFICANT SAVINGS AND BENEFITS WOULD RESULT IF AGENCIES SOUGHT AND ENCOURAGED GREATER USE OF COMPUTER AIDS IN DESIGN

Federal agencies are not actively seeking or encouraging the use of computer-aided methods on Federal building design projects. As a result, agencies are missing opportunities to improve the quality of building designs. Computers, if used efficiently, can provide significant benefits and savings to the building owner, as well as the designer. Design firms are increasingly turning to computer aids because of the existing pressures. 1/ Still, most agency officials seem to prefer the status quo and are reluctant to seek or encourage computer use, including innovative uses, in design.

BENEFITS AND SAVINGS FROM COMPUTER-AIDED METHODS

In comparison to manual design methods, computers can enable designers to produce higher quality, more effective facility planning and architectural designs; reduce the amount of energy consumed by buildings; and lower overall building costs through reduced construction, maintenance, and operating costs. In short, they enable designers to use more accurate analysis approaches, consider more alternatives, and do many things which are impossible using manual design methods.

Used efficiently, computers can improve the way design is done. Computer-aided methods are faster, more versatile, and more accurate than manual design. They can improve both the gathering of design data and its use. They can also permit designers to respond to changing design requirements more rapidly, economically, and effectively than when manual methods are used. However, it must be remembered that computer use cannot be a substitute for sound design judgment. In most cases, it is skillful use that provides the benefits

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1/These pressures do not result from the Federal procurement process. Agencies do not apply pressure directly on firms to make greater use of computer methods. Rather, pressures result from (1) the cost and time needed to do work manually versus the pressure to get work done in less cost and time, (2) the need to use more accurate analysis/design methodologies, and (3) the expectation of many clients that computers will be used.

computers offer, not the mere fact that a computer is being used.

The computer's versatile memory, speed, and ability to manipulate and transfer data are well suited for tasks, such as energy and life-cycle cost analyses, as well as other information processing functions inherent in the design process. This process includes

--assembling, analyzing, and evaluating information in ways that will define design requirements or goals;

--developing and testing design alternatives and selecting and refining a concept into a final design; and

--providing construction information--specifications, drawings, and construction plans--for the final design.

Computers can be used to coordinate the efforts of design teams, eliminating or minimizing many of the problems which often result in poorly designed buildings and construction change orders. Some of the potential ways computer use can improve designs are by

--permitting rapid study of design alternatives to provide a high-quality building;

--providing a tool to quickly evaluate options when project costs must be reduced, or major material or equipment component substitutions must be made due to a supply shortage;

--permitting building designers to completely evaluate and incorporate energy conservation and environmental considerations during the design process;

--providing completed designs and drawings containing fewer errors and without the inconsistencies possible with manual methods;

--providing a systematic process to determine and eliminate interferences between building subsystems and components through an interactive redesign process;

--providing a means of reproducing construction instructions--specifications and drawings--quickly and accurately;

--providing cost savings or good dollar value for expenditures because the design team has the ability

to consider and evaluate more alternatives and eliminate gross overdesign; and

--providing a quickly usable reference base for future maintenance and major modifications/renovations because of changes in building use and/or occupant.

We must emphasize that these are potential benefits. Some can only be realized through integrated use of computer methods by the design team as a whole. Currently, few firms in the United States have computer systems which will allow firms to realize all of the potential benefits listed above. Still, many firms do possess the ability to realize those benefits which do not rely on an integrated approach, such as the ability to consider more design alternatives and to produce more accurate drawings and specifications quickly. The use of computers in building design to date has only scratched the surface. As new and more sophisticated systems are used in the United States, many firms should be able to realize the potential benefits listed.

Computer-aided methods in design can also reduce construction costs. On one British project, the building owner reported construction costs were reduced by 26 percent through the use of a computer-aided building design system. We were told that on a State renovation/restoration project in Hawaii the construction costs were reduced significantly through computer use. The State estimated the construction cost would be between $200,000 and $300,000. Because the design firm was free to consider a variety of design alternatives, it was able to develop a design for which the construction cost was only $50,000. In this case, the State was willing to pay for the computer services used.

Savings and benefits possible through computer use are discussed in more detail in our staff study, "Computer-aided Building Designs," (LCD-78-300, July 11, 1978).

Who benefits from computer use?

It is the building owner, whether the owner is the Government, a business, or an individual, who benefits most from computer use by building designers. While design firms improve their operations and increase their productive capability through the use of computer aids, the major savings and benefits go to the building owner. Efficient use of computers makes it possible to design better buildings, buildings which

--are less costly to construct because they have less overdesign and fewer conflicts or interferences between building subsystems and components,

--consume less energy and have lower operating costs, and

--more adequately meet the users' needs.

These benefits are greatly increased if integrated computer systems are used. 1/ Computers can also increase the building owner's control over the total design process and limit the number of unexpected conditions in building construction and operation.

DESIGN FIRMS ARE TURNING TO COMPUTER METHODS

More design firms are turning to computer-aided methods to replace or supplement traditional manual methods. The existing building design environment is one of the driving forces behind this movement. Using manual methods, architects and engineers do not have the time they need to do all the tasks they are being asked to do as part of the design process. We found that more than 76 percent of the firms responding to our questionnaire were using some computer-aided design methods when providing architect-engineer services to their clients.

Existing design environment forcing greater computer use

The existing building design environment is forcing more design firms to expand their use of computer methods in their practices, or in some cases, to start using computer aids in design. Increasingly, the use of yesterday's tools to design tomorrow's buildings is not an acceptable practice.

Buildings have become more complex over the past decade. Building codes are including more energy, environmental, health, and safety requirements. Also, greater emphasis is placed on making new buildings respond to user needs. As a result, today's buildings are more complex and sophisticated, and therefore, more difficult to design.

1/By integrated systems, we mean computer systems composed of many application programs that are able to turn output from one program into input for another program.

Further, building designers are being required to do more analytical work, such as earthquake analyses, energy use forecasts, solar energy studies, and life-cycle cost calculations.

Federal agencies are under constant pressure to save both time and money in constructing new buildings. At the same time, they are being directed to conserve energy by using better designs, to consider life-cycle costs, and to make public buildings more responsive to public needs. Architects and engineers, who must respond to the pressure, state that these new requirements increase costs and lengthen design time. Computers can help relieve some of the pressure by giving designers more time to do required tasks, and many firms are starting to use computer aids for this reason.

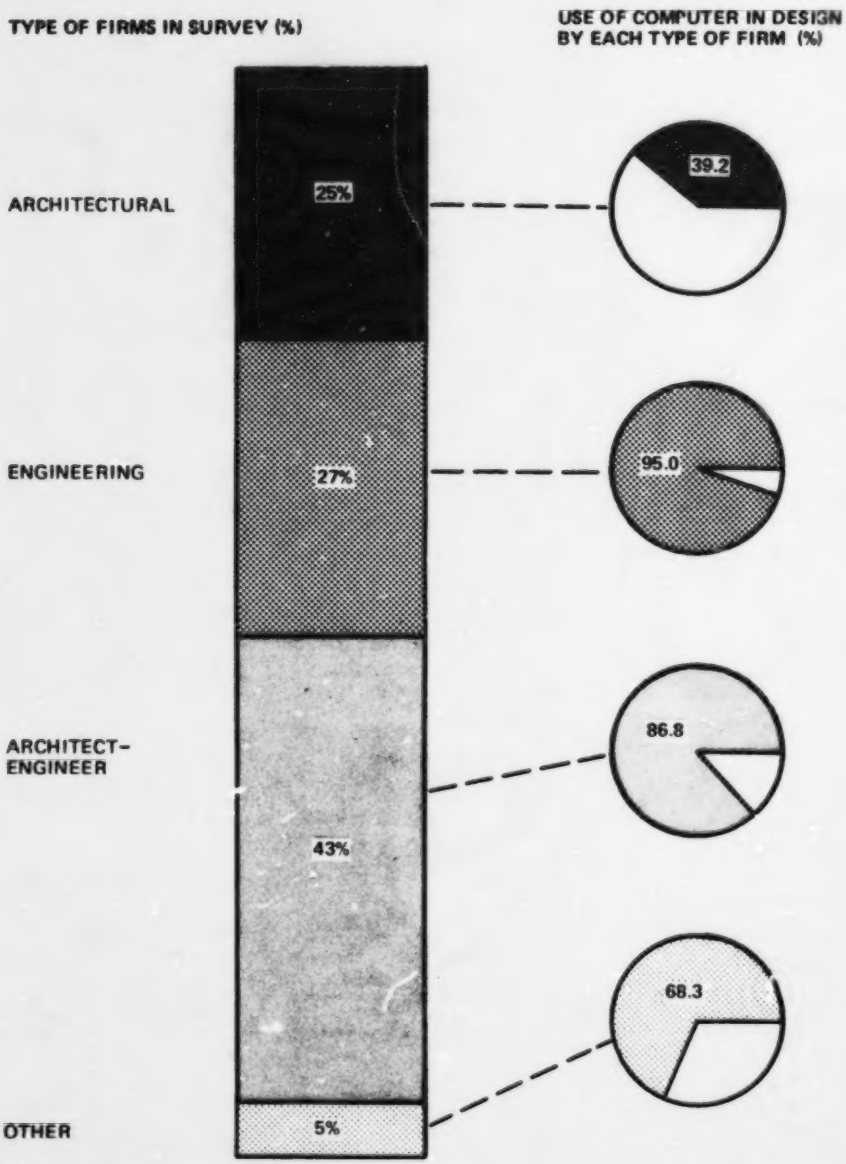
Use of computers by design firms

Computer applications being used by American architect-engineer firms are primarily stand-alone programs developed for a single purpose. Computers are being used in nearly all aspects of the design process by one firm or another. The majority of the firms responding to our survey either had in-house computer capability or had access to computer services through outside sources.

Our survey of architectural and engineering firms showed that 76.1 percent (567 of 745) used computers in some way to provide design services to their clients. (See fig. 2-1 for a breakdown of computer use by type of firm.) On selected Federal projects, our analysis showed a slightly lower use of computer-aided methods--64.5 percent (477 of 740 projects). Five firms did not respond to the questions about the specific Federal project. As we expected, architects use computers considerably less than engineers. None of these figures showed the degree to which firms used computers in design. Some used computers in only one or two areas, where others made extensive use throughout the entire design process.

We analyzed the computer use by project type. While the sample was not statistically reliable, the results were interesting and revealing. (See fig. 2-2.) For example, the only project type where computer use was less than 50 percent was for facility renovations (42.4 percent--39 of 92 projects). This was not a surprise because we were told many times throughout the review that computers were not used much on renovation work. A major inhibitor to such computer use is the absence of an existing computerized building design data file.

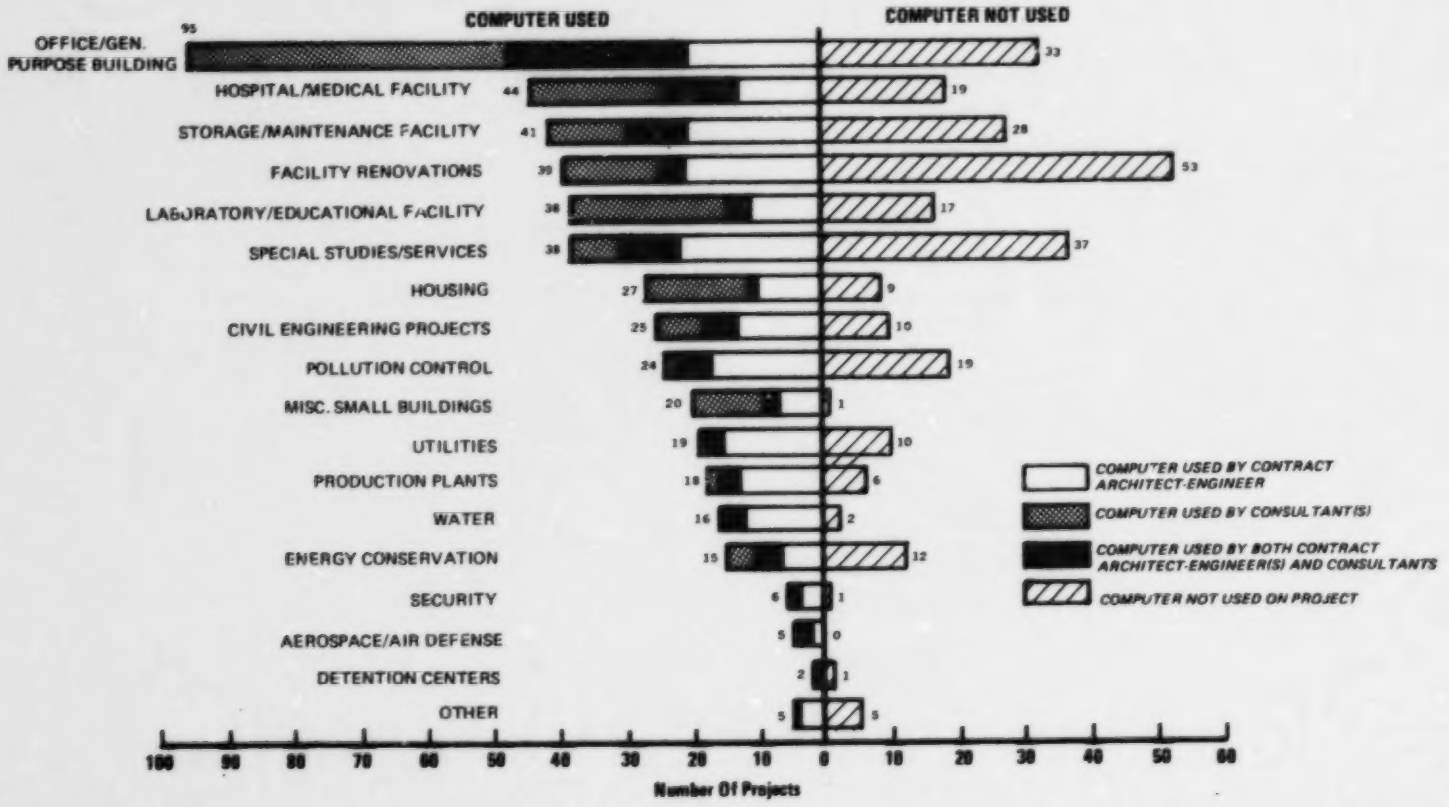
FIGURE 2-1
ARCHITECTURAL AND ENGINEERING FIRMS
USING COMPUTERS IN THE DESIGN PROCESS



Note: Taken from 745 firm samples.

Figure 2-2

USE OF COMPUTER–AIDED METHODS ON SELECTED FEDERAL PROJECTS



We were surprised about the lower than expected use of computers for energy conservation projects (55.6 percent--15 of 27 projects) and the high use of computers on small buildings (95.2 percent--20 of 21 projects). The reason for the lower use on energy projects was probably the nature and scope of projects classified as energy conservation. The higher than expected use of computers on small buildings, such as bowling alleys and chapels, was a surprise because many people told us that computers were not used on small buildings. Most thought the buildings were not complex enough to use computers. Only aerospace and air defense facility projects showed a 100-percent use of computers (five of five projects).

When asked why they used computers, nearly 45 percent of the firms indicated that the primary reason was to carry out tasks not practical using manual techniques. (See fig. 2-3.)

We also asked computer firms if they planned to use new computer applications through December 1980. The responses to this question showed a trend toward computer-aided specifications (100 firms), cost estimating (71), life-cycle costing (61), and energy analysis (55). (See fig. 2-4.)

More detailed information on the results of the questionnaire survey is provided in our staff study, LCD-81-2.

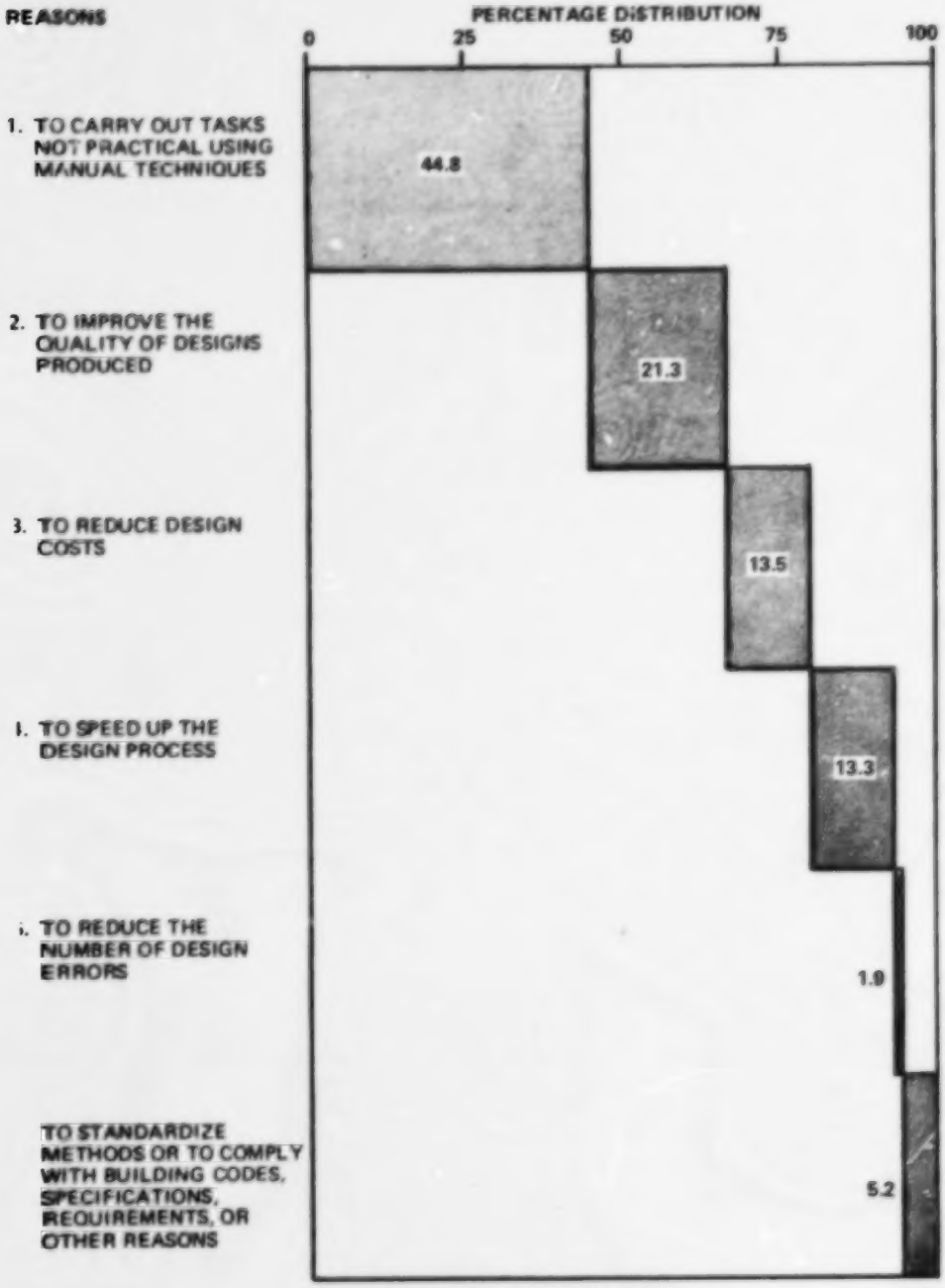
AGENCIES NEED TO ENCOURAGE THE USE OF COMPUTER-AIDED METHODS

Federal policies and procedures in general do not encourage innovation in design. Agencies generally prefer designers to use proven technologies or processes that do not require technical innovation. Still, technical innovation may be what will be required to achieve the President's energy conservation goals, to improve the quality of Federal buildings, and to improve the ability of public buildings to fulfill user needs. These goals were not always met in 1979.

Many of the architects and engineers we contacted believed that most Federal agencies were so set in their ways and rigid in their management that they actually stifled innovativeness and rejected creative thinking by design firms. Our discussions with agency officials confirmed that, in most cases, they were not really interested in new and creative designs. Most officials preferred the tried and tested design concepts. Some agencies' officials emphasized that the Government should not be pushing the state of the art forward. They believe this is the role of the private sector. However, none

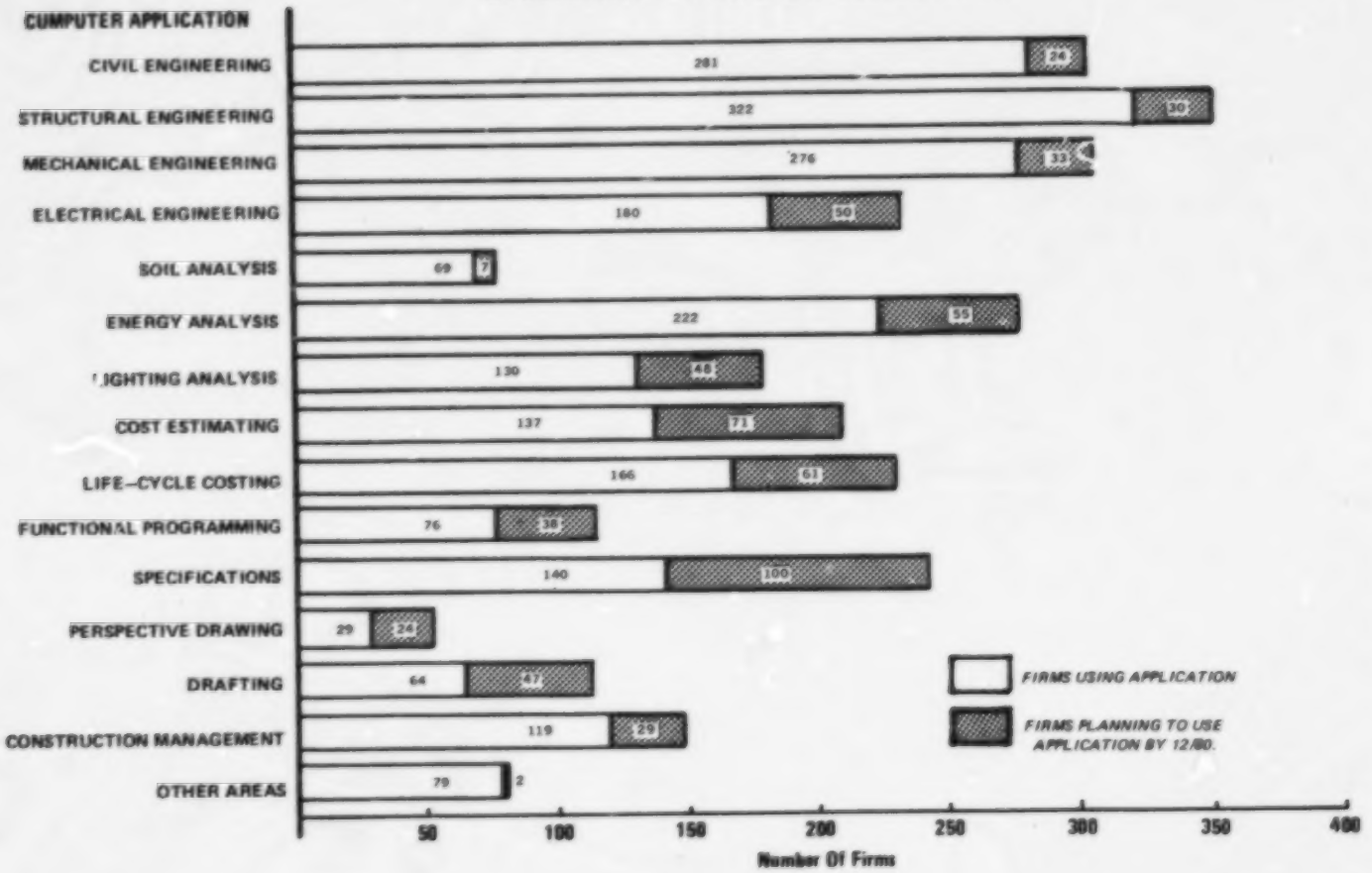
FIGURE 2-3

PRIMARY REASONS COMPUTERS ARE EMPLOYED IN THE DESIGN PROCESS



Note: Based on responses from 745 firms.

Figure 2-4
AREAS WHERE ARCHITECTURAL AND ENGINEERING FIRMS ARE PLANNING
(BY DECEMBER 1980) TO INCREASE COMPUTER USE



recognized that this thinking has inhibited the advancement of the state of the art.

Design firm officials told us that innovative use of the computer is seldom encouraged, if ever. In some cases, it is effectively discouraged by statements, such as "only programs having approved documentation shall be utilized" or "any program proposed for use shall be submitted for approval prior to its use." Architects and engineers feel that these statements suggest that they might use incomplete, unchecked, or erroneous computer programs even though they are fully responsible for the design of the product. According to officials of several firms, the Government is not seeking state-of-the-art design work or quality designs, and agency officials refuse to be concerned about how the design work will be done. The Government's primary interest is how much the design services will cost.

Most agency officials are reluctant to actively pursue the use of computers on Federal projects because agencies fear being accused of limiting competition. On the basis of our survey results, we believe such accusations, which would undoubtedly be made, would be unfounded. We recognize that our survey is not a statistically representative sample, and therefore, it should not be interpreted to represent the entire architect-engineer community. Nevertheless, because of the high return, we believe the survey adequately demonstrates that sufficient numbers of firms have internal computer capability or have access to computer capability to provide for adequate competition. (See fig. 2-5.) Much of the concern is directed toward the minority and small business firms. Our survey showed that two-thirds of the minority firms and 76 percent of the small business firms responding to the questionnaire have computer capability or have access to it. (See figs. 2-6 and 2-7.)

Agencies generally believe that it is not their role to encourage or push the use of any particular design method. Most agency officials believe that a design firm will use computers when and if the firm's operations can be improved and the use is cost effective. The computer gains that have occurred so far are evidence that computers can indeed improve a design firm's operations and are cost effective. However, as pointed out earlier, the major benefits and savings from computer use accrue not to the design firm, but to the building owner.

Figure 2-5

Analysis of How Computer

Services Are Provided

Type of firm	Methods													
	Using computers		Own computer		Lease computer		Time sharing		Service bureau		Consultant		Other	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
Architect	73	39.2	9	12.3	5	6.8	18	24.7	16	21.9	30	41.1	6	8.2
Engineer	190	95.0	90	47.4	16	8.4	93	48.9	62	32.6	23	12.1	9	4.7
Architect-engineer	276	86.8	137	49.6	43	15.8	141	51.1	85	30.8	61	22.1	8	2.9
Other	28	68.3	16	57.1	4	14.3	14	50.0	7	25.0	3	10.7	3	10.7
Total	567	76.1	252	44.4	68	12.0	266	46.9	170	30.0	117	20.6	26	4.6

FIGURE 2 6

USE OF COMPUTERS BY THE 30 MINORITY FIRMS RESPONDING TO QUESTIONNAIRE

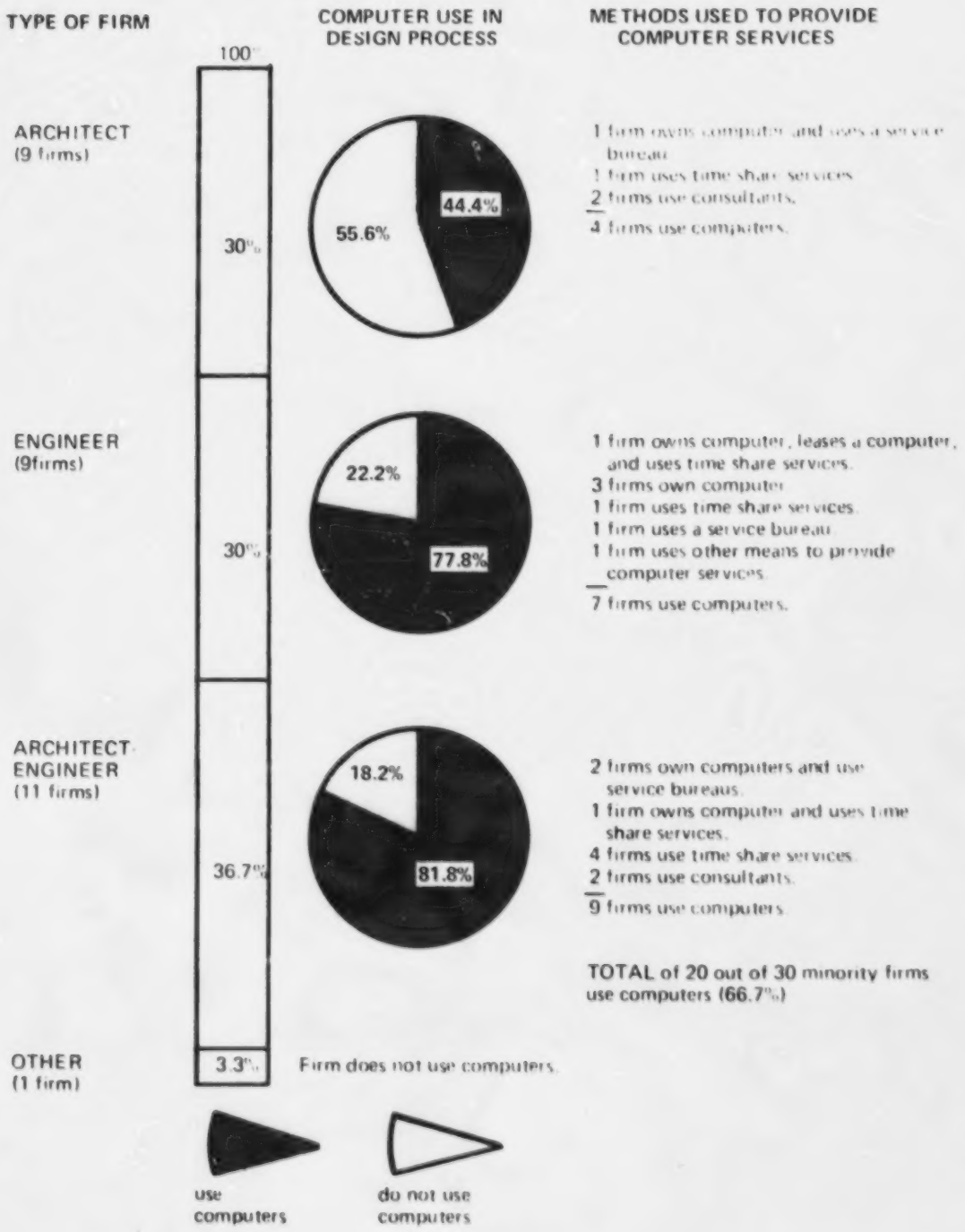
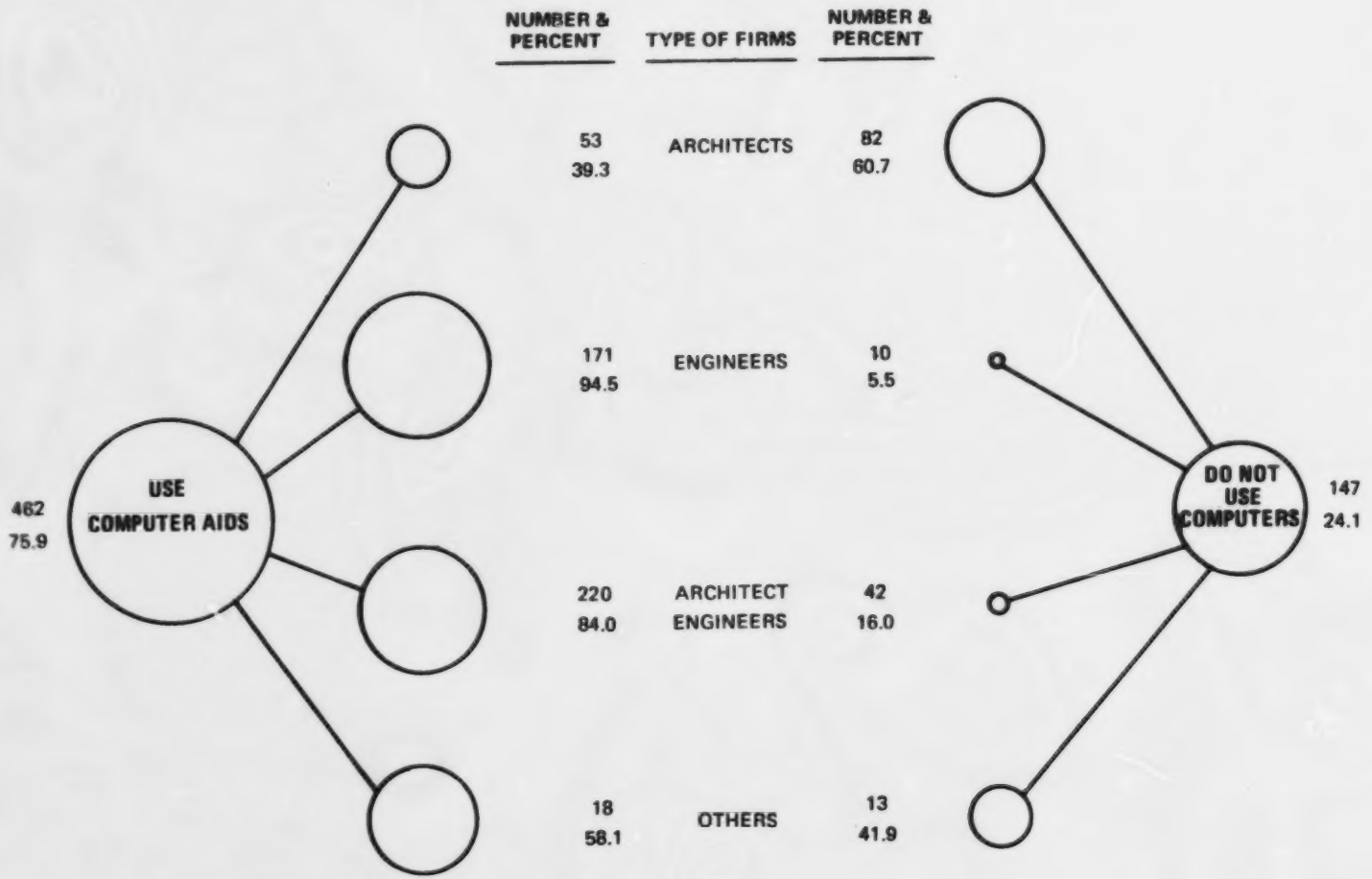

TYPE OF FIRM
COMPUTER USE IN DESIGN PROCESS
METHODS USED TO PROVIDE COMPUTER SERVICES
100%
ARCHITECT (9 firms)
30%
44.4%
55.6%
1 firm owns computer and uses a service bureau
1 firm uses time share services
2 firms use consultants
4 firms use computers
ENGINEER (9firms)
30%
22.2%
77.8%
1 firm owns computer, leases a computer, and uses time share services
3 firms own computer
1 firm uses time share services
1 firm uses a service bureau
1 firm uses other means to provide computer services
7 firms use computers
ARCHITECT-ENGINEER (11 firms)
36.7%
18.2%
81.8%
2 firms own computers and use service bureaus
1 firm owns computer and uses time share services
4 firms use time share services
2 firms use consultants
9 firms use computers
TOTAL of 20 out of 30 minority firms use computers (66.7%)
OTHER (1 firm)
3.3%
Firm does not use computers
use computers
do not use computers

Figure 2–7

USE OF COMPUTERS BY SMALL BUSINESS FIRMS RESPONDING TO QUESTIONNAIRE



SMALL BUSINESS CRITERIA USED: ARCHITECTS–AVERAGE ANNUAL FEES OF LESS THAN $2.0 MILLION OVER LAST 3 YEARS. ENGINEERS, ARCHITECT-ENGINEERS, AND OTHERS–AVERAGE ANNUAL FEES OF LESS THAN $7.5 MILLION OVER LAST 3 YEARS.

There is no incentive for the firm to use computers, and thus, increase operating costs in areas where the benefits go to the owner. Unless the owner provides some incentive or requires computer use, the computer will generally be used only when it is advantageous for the firm.

A sort of "chicken or the egg" situation has evolved. On the one hand, design firms contend that they will improve computer capability if and when their clients demand computer services. On the other hand, Federal agencies, the major clients of many firms, state they will require computer use when enough firms have sufficient capability to ensure competition. The agencies' concern about competition is no longer a valid concern because a sufficient number of firms have computer capability or contracts for these services. They also have the power to control the processes used for design through procurement and design review procedures.

CHAPTER 3

AN ENVIRONMENT CONDUCIVE TO EFFICIENT COMPUTER USE GENERALLY HAS NOT BEEN CREATED

Federal agencies have not created a environment which promotes and supports the efficient use of computer-aided design methods. As a result, the potentials of computer use are not being realized. Architects and engineers are often not making as great a use of available computer capabilities on Federal projects as possible. Our discussions with design firms and Federal officials indicated that this situation can be attributed primarily to (1) the Federal officials' general lack of understanding about computer-aided design methods and their related costs and (2) restrictive procedures and actions in contract negotiations and project management.

AVAILABLE COMPUTER CAPABILITIES ARE NOT BEING USED ON FEDERAL PROJECTS

Of the firms indicating they had computer-aided specification capability available to them, only 31 percent used this tool on the Federal projects included in the survey. Likewise, only 33 percent used their computer-aided cost-estimating capability. Other applications used on all types of projects showed similar use. (See fig. 3-1.)

LACK OF UNDERSTANDING

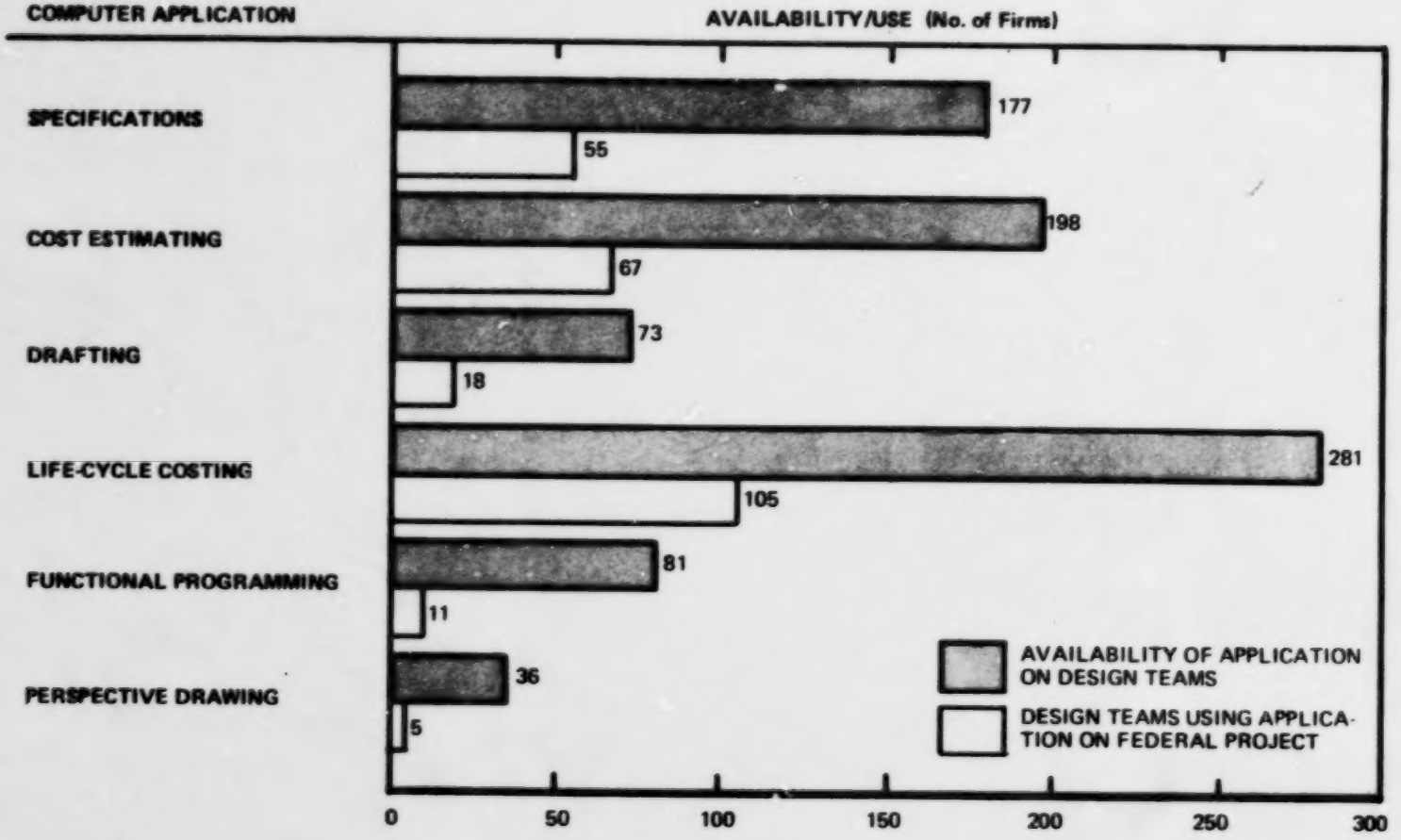
The top management of design firms often cited the Government employees' general lack of knowledge and understanding about computers as a problem when working for Federal agencies. Firms indicated that generally their clients from the private sector also lack an understanding of computers, but they usually do not get involved with how a job is done the way Federal agencies do. This problem manifests itself in two aspects of a project--the contract negotiations and the project review.

Contract negotiations

Computer use is frequently limited by actions and decisions made during contract negotiations. Many agency negotiators are not fully aware of how computers can be used during design or what computer services should cost. Design firms complain that when discussing the fee, agency negotiating teams often try hard to get the lowest possible price and do not consider the value of the computer work proposed. They indicate it is easier to reach a mutually acceptable

FIGURE 3-1

COMPARISON OF COMPUTER APPLICATIONS AVAILABLE TO ARCHITECTURAL AND ENGINEERING FIRMS AWARDED FEDERAL CONTRACTS AND THE APPLICATIONS ACTUALLY USED



agreement on scope and fee when Federal negotiators understand why and how computers are being used and have a fairly good idea of what a reasonable cost should be for the computer services proposed.

Computer-aided methods are creating some difficulties in negotiating the mechanical engineering portion of contracts. Firms cited problems negotiating fees when an energy analysis was required. They claimed agency negotiators did not recognize that an energy analysis involves more than just computer run costs. Mechanical engineering labor costs can also increase without increasing the number of drawings produced. (Some negotiators use cost per drawing as a rule of thumb to evaluate the reasonableness of costs.) Negotiators frequently questioned the labor hours estimated for mechanical engineering.

Agency officials told us there was some validity to all these complaints. According to these officials, many negotiating teams consist of both design and procurement personnel, while some consist of only one or the other. Also, often procurement personnel do not have knowledge about design or the use of computers in design. They also acknowledged that some of their negotiators sometimes placed too much emphasis on getting the lowest possible price. Agencies could not agree among themselves whether cost per drawing was still a valid rule of thumb. Some agencies say this is an antiquated tool, while others claim it is still a valid and useful tool.

Project management and review

Agency technical or design personnel also do not always have a good understanding of computer use in design and are often unaware of advances being made in this area. This situation existed in every agency we reviewed. Some agency personnel we interviewed were quite knowledgeable and up to date on the state of the art on computer use in design; some had little knowledge of computer-aided design. However, the majority of Federal personnel we talked with fell somewhere in between these two extremes.

Agency design personnel can hamper computer use when a design firm uses or proposes to use a computer program the agency personnel are unfamiliar with or use a computer application they have never seen before. The approach of the agency personnel involved in such a situation often has a bearing on whether the computer is used on the project, and frequently whether it is used on future work for the agency involved.

Design firm officials said they understood the problem and appreciated the agency personnel's concern. They told us that some agency personnel approached the problem receptively and tried to determine quickly whether the computer would provide the needed answers or a good product. Others are negative in their approach, requiring lengthy justification of the use of the computer which thoroughly convinces them that the computer will provide good results. Many firms objected to being continually required to educate agency personnel, at their own expense, about computer-aided methods. They pointed out that agency negotiators would not allow the costs of demonstrating how a computer program works. Negotiators expect firms to absorb these costs if demonstrations are necessary. As a result, some firms prefer not using computer-aided methods if computers will create problems or delay projects.

Effect of the problem

It is difficult to illustrate the effect of the problem on the quality of a design. Many other factors are involved, besides computers, which make it hard to show that the quality of a building is less than it could have been had agency officials not limited or hampered computer use. Perhaps it can be illustrated best by showing where or how computers affect the final design.

Design is not an exact science. There are many ways to arrive at a design solution, and there is no one correct solution to a design problem. Design is a complex decisionmaking process through which a designer proceeds along empirical (trial and error) and heuristic lines to find solutions to meet the requirements of the client, society, and nature. While there are many possible solutions to any design problem, some are better than others. This leaves a vast gray area between an acceptable design and a good design. It is in this area that negotiators hamper and limit the use of computers by design firms. The real benefits to be derived from computer methods are those which can be achieved by moving a design from acceptable to good. The limiting of computer costs reduces the amount of effort firms are willing to spend to save the Government construction costs and future operating costs. Some firms have concluded that the Government is not interested in acquiring good quality design, but rather only a design that can be constructed within the budget estimate.

Some negotiators were quick to point out that paying more for computer services would not guarantee a better design. We agree. However, not allowing enough for computer services presents an even greater probability that the design delivered

will not be as good as it should or could be in terms of overall quality, energy efficiency, or in fulfilling the user's needs.

Comments from agency negotiators and design personnel

We talked with contract negotiators and design personnel from each agency and found that their knowledge about computer use in design and the related costs varied a great deal. Many believe that firms will use computers if it is economical, and that the total costs will be the same whether computers are used or not. Such comments show a total lack of awareness about computers and how they are or can be used in the design process.

Most of the contract and pricing personnel we talked with acknowledged they knew little, if anything, about design and the use of computers in design. We found that even design personnel's knowledge of computer methods varied widely depending upon background, age, and other factors. For example, because of the education received and long experience with computers, structural engineers were usually more knowledgeable about computers than architects. In addition, young engineers in mechanical engineering were more apt to be knowledgeable than older engineers in the same area because of recent advances in computer applications within this discipline.

As a result of our discussions with agency personnel, we believe that many do not understand or appreciate advances which have been made in computer-aided design methods or how they have affected or can affect design firm operations. Many of the Federal officials regard the computer as only a sophisticated calculator which can speed up the design process. Little attention, if any, is given to the nonanalytical functions computers can perform during the design process, such as functional space planning, computer-aided specifications, automated drafting, cost estimating, and other information processing activities.

Many agency officials believe that any savings in labor costs realized through computer use will cover the increase in computer costs. This attitude tends to inhibit architects and engineers who try to use the "saved time" to improve the quality of their products by making a more complete analysis or by analyzing more alternatives. Our staff study on computer-aided building design states that much of this saved time is used to do things which (1) should be done but time normally will not permit or (2) cannot be done by manual methods.

ACTIONS AND PROCEDURES LIMITING AND HAMPERING COMPUTER USE

We found that, in general, Federal policies do not hamper or inhibit the use of computers by architects and engineers. However, there is evidence that actions by Federal employees interpreting policy do, in fact, inhibit, restrict, and hamper the use of computers by design firms, as do some agency operating procedures.

Actions

We talked with Federal officials involved in both contract negotiation and project management and review. The majority said they neither encouraged nor discouraged computer-aided methods.

Private architects and engineers generally disagreed with these comments. They cited numerous instances where the actions of Federal officials clearly, even though not always intentionally, discouraged, hampered, or limited the use of computers on Federal projects. For example, some agency officials (1) required that only computer programs they had approved be used, (2) limited the number of alternatives the architect-engineer firm could consider, (3) removed certain alternatives from consideration, or (4) limited the number of computer runs they would pay for under the contract. All these actions can hamper the effective use of computers and discourage or limit extensive and innovative uses of computers.

Attitudes toward computer costs

Federal officials generally claim to maintain a neutral attitude toward the use of computers. Yet, firms often cited the attitude of Federal officials toward the cost of computer services as a problem. Firms feel a lack of understanding on the part of contract negotiators as to the complexity and costs of computer services contributes to this attitude. Firms feel that this attitude has caused services, such as energy analyses, to be limited in scope or deleted from a project. We were told that some contract negotiators rejected all computer costs classified as direct costs, and that auditors have been inconsistent in their decisions regarding the proper classification of these costs. Some firms said they will no longer do work for certain agencies because these agencies are unwilling to pay a fair price for the required services.

Required specification formats

Many firms complained about agency views toward computer-aided specifications. Firm officials said they were often unable to use their own specification program because the output did not conform to agency specification guidelines. We were told that most agencies are very rigid in their refusal to accept specifications that do not conform to their unique format. Several agencies included in the review confirmed this statement. Officials of one firm gave an instance where computer-aided specifications had been used and the agency rejected the specifications in total. The firm was forced to redo the specifications manually and resubmit the package. The firm claimed that the only reason the specifications were rejected was because the agency's format had not been followed, and that the text was essentially unchanged. A firm with older systems frequently cannot use the computer for specifications because its printers cannot produce lowercase characters. Agency formats generally require specifications to be printed in uppercase and lowercase characters. The rigid enforcement of this formating requirement prevents many firms from using computer aids for specification preparation. The president of one firm told us of one occasion where an agency official had informed him that the agency would not award a certain contract to him if he insisted upon using his own specification program on the project. He insisted and consequently did not receive the contract, although the agency apparently felt he was the best qualified for the job.

Paper size requirement

A more universal complaint, one recognized by all as a nuisance more than a problem, was the insistence of most agencies that all specifications, reports, and other similar submissions, be on Government size paper--8" x 10-1/2". Some firms, especially those away from Federal centers, have difficulty buying this size paper and usually have to cut commercial size paper--8-1/2" x 11"--down to comply with the requirement. This frequently increases production and reproduction costs, thus increasing Federal costs without improving the quality of the design. Some of the agencies had already discontinued the practice of requiring Government size paper and had started to stipulate width of the upper and left-hand margins. A recent change in Federal policy--the decision to use commercial size paper--should eliminate this problem.

Prior approval of
energy analysis programs

Firms complained about the Navy's practice of restricting the use of energy analysis programs to those appearing on a list of approved programs. We were told that any program not on the list must be approved before it is used on a Navy project. Only commercially available programs have been placed on the list. Firms having their own energy programs objected to being required to use a program on the list, since they have to take professional responsibility for the results. They are also paying royalties to use someone else's program, when they have a program of their own which they prefer, understand, and feel more confident using. None of the other agencies involved in the review had such a policy.

We discussed this matter with Headquarters, Naval Facilities Engineering Command officials, who advised us that they would look into the situation. Subsequently, corrective action was taken. On April 15, 1980, command headquarters sent a letter to all field divisions directing that the use of the approved energy program lists be discontinued. It stated that providing specific names of suitable programs may still be helpful to architect-engineers, but they should be referred to as a partial list of programs known to meet requirements. It further stated that references to and use of the term "approved list" should be deleted from guidance provided to architect-engineer firms.

CHAPTER 4

CONTRACT NEGOTIATIONS COULD BE IMPROVED BY REVISING FEE PROPOSAL FORMATS

In general, the fee proposal formats most Federal agencies use to acquire architect-engineer services completely ignore computer-aided methods. Most agencies have not revised their proposal formats to recognize the computer as a cost element in the architect-engineer's fee. Only a few formats clearly show the services to be provided or whether computer-aided methods will be used. Also, formats lack uniformity which creates confusion among architects and engineers doing work for more than one agency.

COMPUTER COSTS SHOULD BE CONSIDERED

Only one of the fee proposal forms used by Federal agencies--the Department of State--provides space for computer costs to be listed, and only two procuring offices (see p. 29) mention the computer in the written instructions they give to architects and engineers. Procurement regulations provide no specific guidance, and negotiators and auditors vary in the way they interpret the regulations. Firms are generally left to decide on their own where to list their computer costs, and then agencies frequently question the way these costs are classified.

Computer costs are an important element of a fee proposal for architect-engineer services. Contract negotiators must know how the design firm plans to use computer aids on the project, because computer use has a direct bearing on the reasonableness of the fee. For example, before negotiators accept a drafting cost as fair and reasonable, negotiators should know how drawings are to be produced. A cost that is reasonable for manually prepared drawings is not necessarily reasonable if the drawings are done with an automated drafting system. Depending on the complexity and type of the drawings, the cost could be either higher or lower using the computer-aided method.

Fee proposal formats do not provide for computer costs

Only 1 of the 17 fee proposal formats we found being used for architect-engineer services specifically asked that computer service costs be included in the fee proposal. In

1979 the Department of State adapted for agency use the American Institute of Architects' Document B161 - Agreement Between Owner and Architect for Designated Services and Document B162 - Scope of Designated Services. This latter document includes computer applications as one of the designated services. The Department of State retained this item in its form (see fig. 4-1). Its contract document defines computer applications as follows:

> "17.9.17 COMPUTER APPLICATIONS services consisting of computer program development and/or computer program search and acquisition, plus on-line computer time charges, for:
>
> .01 Programming
> .02 Economic feasibility analysis
> .03 Financial analysis
> .04 Site analysis
> .05 Construction cost estimating
> .06 Detailed project scheduling
> .07 Market analysis
> .08 Architectural analysis and design
> .09 Structural analysis and design
> .10 Mechanical analysis and design
> .11 Electrical analysis and design
> .12 Production of drawings
> .13 Construction cost accounting"

In addition to the computer applications caption, computer costs could be listed under a number of other designated service categories, including special studies, life-cycle cost analyses, and energy studies.

Unclear where computer costs should be shown

Architect-engineer firms are usually not given any written guidance on where to list computer costs in the fee proposal. Generally, firms said they decided, on their own, where to show their computer costs or where to bury or hide these costs. Two procuring offices, however, do provide some instructions, but even this guidance is not explicit.

The San Francisco Operations Office, Department of Energy, instructs firms to include computer rental costs under the category "Other Direct Costs." However, no guidance is given regarding computer costs relating to a firm-owned computer. The Corps of Engineers' Pacific Ocean Division instructs firms to list computer service costs under "Fixed Costs." While most

SCHEDULE OF DESIGNATED SERVICES - PHASE 9: SUPPLEMENTAL SERVICES

The Government and the Architect-Engineer, respectively, shall provide for this Phase of the Project those services appropriately designated and assigned below and described subsequently.	By Architect-Engineer	By Architect-Engineer as Outside Services		By Government, coordinated by Architect-Engineer	By Government	By Architect-Engineer as Additional Service	Not to be Provided	Method of Compensation	
17.9.01 Special Studies									
17.9.02 Renderings									
17.9.03 Model Construction									
17.9.04 Life Cycle Cost Analysis									
17.9.05 Value Analysis									
17.9.06 Quantity Surveys									
17.9.07 Detailed Construction Cost Estimates									
17.9.08 Energy Studies									
17.9.09 Environmental Monitoring									
17.9.10 Tenant-Related Services									
17.9.11 Graphics Design									
17.9.12 Fine Arts and Crafts Services									
17.9.13 Special Furnishings Design									
17.9.14 Non-Building Equipment Selections									
17.9.15 Public Relations									
17.9.16 Expert Witness									
17.9.17 Computer Applications									
17.9.18 Materials and Systems Testing									
17.9.19 Demolition Services									

Figure 4-1. Page from the Department of State's Schedule of Designated Services showing computer applications as a supplemental service.

forms do not clearly show where computer costs should be listed, some Federal officials said these costs can be listed under the "other" caption on the forms. However, this is not widely known in the private sector, possibly because some negotiators, as discussed in chapter 3, will not permit computer costs to be listed as a direct cost.

In general, agency officials do not agree on how computer costs should be classified or where they should be listed in the fee proposal. As a result, firms do not always know where their computer costs should be listed. This situation has created a great deal of confusion and misconception in the private sector.

Procurement regulations do not state specifically how to handle computer costs. The regulations, however, do provide some guidance without mentioning computers specifically. The problems which have been brought to our attention have generally resulted not from the policy, but from the various ways auditors and negotiators have interpreted the regulations.

Uniform guidance needed

This lack of specific guidance has led to varying interpretations by Government negotiators and auditors, even within the same agency or office. For example, one firm was given different interpretations by Defense Contract Audit Agency auditors on two different preaward audits. The firm was told to show its computer costs as a direct cost on one contract and as overhead on another similar project. Officials of this firm are confused and are not sure where they will list their computer costs on their next job for this agency. Officials in another firm were directed to "bury their computer costs in direct labor or absorb them in overhead." They objected because they felt the first alternative was dishonest, and the second was unfair since it would inflate their overhead. Officials in a third firm were told "to bury their computer costs in their man hour costs by inflating the hours." They thought this was a backhanded way of handling computer costs.

Some firms have the impression that they must bury or hide their computer costs in their fee proposal either because none of the forms provide a space or line for these costs, or because they have been told to do so by a Federal employee. Others do not use computer methods unless necessary on Federal work, thereby avoiding all the hassle about the costs for computer services and their proper classifications.

Firms which have had problems with computer costs during contract negotiations usually showed these costs as direct costs. Still, those firms absorbing these costs in overhead also have had problems. For example, prior to submitting a proposal, one firm was told by the agency to absorb the computer costs in overhead. Then during the negotiations, the agency challenged the firm's overhead, saying that it was too high. At the other end of the spectrum are firms that have listed computer costs as a separate direct cost and have had no problems, sometimes dealing with the same agencies which had rejected this approach when used by other firms.

A TASK-ORIENTED FEE PROPOSAL WOULD BE MORE USEFUL

The negotiating process could be improved by revising the fee proposal format most agencies use. Redirecting the emphasis of the proposal from prescriptive--"who will do the work"--to performance--"what work will be done"--will insure that all parties clearly understand what work the fee will cover. This format will do a better job giving negotiators the information they need to determine whether a proposal is fair and reasonable.

What is a task-oriented proposal?

A proposal which is based on the work to be done, rather than who will do the work, is a task-oriented performance-based proposal. This does not necessarily mean that responsibility for each task is not assigned to a specific discipline, such as the architect, structural engineer, mechanical engineer, and so forth. It simply means that this assignment of responsibility is based on the tasks required to complete the job, rather than on the job in total.

The tasks are determined using task analysis techniques. Task analysis is the process of breaking down the work necessary to satisfy project requirements into component parts. The purpose of the analysis is to help identify, define, and understand the work to be done. The Department of Health and Human Services calls this process the preparation of the architect-engineer statement of work on scope of services. In one of its Technical Handbooks, it makes the following statements about the importance of this process.

> "* * * A well prepared A/E statement of work avoids price negotiation problems, eliminates ambiguities, and assures that the design will satisfy program needs. If legal problems arise for whatever reason,

a comprehensive A/E statement of work protects the interest of the Government. * * *"

We believe a task-oriented proposal gives contract negotiators a better tool to work with because it (1) shows the services to be provided and (2) identifies requirements which may have been overlooked or inadequately covered. It also clearly shows whether the architect-engineer firm understands the project requirements. This will facilitate more meaningful discussions, including those on intended computer uses.

Some agencies are already using a fee proposal breakdown which is task oriented. They include the Department of State (see fig. 4-1), the Department of Health and Human Services (see fig. 4-2), the National Park Service (see fig. 4-3), and the Corps of Engineers' Pacific Ocean Division (see fig. 4-4).

Some firms contacted preferred the task-oriented proposal because, in their opinion, it is really the only way to develop a good cost estimate, especially on complex projects. They feel it is too easy to overlook something using the discipline-oriented format. They generally develop their initial estimate by task and then have to revise the estimate to fit the agency's proposal form. Many of these firms have developed and used their own proposal forms on non-Government work. These forms are also used as backup material for the Government proposals.

Some agency officials are concerned that a task-oriented fee proposal may not provide a verifiable cost breakdown which is consistent with the firm's method of accumulating costs. We recognize that this could occur if the format used does not preclude this from happening. The Department of Health and Human Services proposal form does this by calling for (1) a fee proposal breakdown showing effort in staff days and (2) a fee proposal summary showing the pricing of the effort to be expended and other costs applicable to the contract, such as travel and reproduction costs.

The variety of formats used causes confusion

Nearly every organization has developed fee proposal forms to use in contracting for architect-engineer services. This creates some confusion, especially when two offices of the same agency use different forms. Thirteen different basic fee proposal forms were being used by the 15 procuring offices we visited (see app. III). Some of these offices had

TAB-B1

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF FACILITIES ENGINEERING

A/E FEE PROPOSAL BREAKDOWN

PHASE ____ SAMPLE ____ (All Effort in Man-Days)

TASKS \ PARTICIPANTS	DESIGN & PLANNING	ARCH.	STRUCT.	MECH.	CIVIL	ELECT.	SPEC.	COST ANALYSIS	PROJECT MGT.	DRAFTSMEN	
a. Familiarity with management plan & establish communication	5	2	1	2	1	1		2	10		24
b. Report on Design Criteria	12	4	1	5	1	5		4	2		34
c. Visit site, review and comment	10	5	5	5	5	5		5	5		45
d. Boundary & topographic surveys and soil borings			LUMP	SUM	SEE	TAB--B2					
e. Preliminary seismic investigation			20	30					5		55
f. Verify and propose adjustments to management plan and time schedule	2	2	2	2	1	2		1	10		22
g. Order of magnitude cost estimate		5	2	5	2	5		10	2		31
h. Review and comment on CM Contract	2	2	1	1	1	1	2	1	5		16
i. Assist in environment assessment			NOT	USED							
j. VM and Life Cycle Cost Studies		5	5	5	5	5	5		10	5	40

FORM FEC 4-17 (Rev. 7/78)

Figure 4-2. Department of Health and Human Services fee proposal form.

Figure 4-3. National Park Service fee proposal format.

Project Title
Contract No.

ARCHITECT-ENGINEER CONTRACT
SUMMARY OF PROPOSED PRICE

EXHIBIT A

Description of Work Items	Direct Labor Category	Hourly Rate	Est. Hours Required	Total Direct Labor Cost	Overhead Rate _____% Cost	Other Direct Costs	Total Costs	Profit	Total Price
1	2	3	4	5	6	7	8	9	10

35

XXXa.

"SAMPLE FORMAT"

(Date)_____

Indicate here the contract title
Per Scope of Work

ESTIMATE:

Direct Labor a. b. c. d. Etc.	$_____
OVERHEAD ON DIRECT LABOR: (%)	$_____
GENERAL AND ADMINISTRATIVE OVERHEAD: (%)	$_____
MATERIALS AND SUPPLIES:	$_____
TRANSPORTATION: (Air Fare, Car Rental, etc.)	$_____
OTHER FIXED COSTS:	$_____
SUB-TOTAL	$_____
PROFIT: (%)	$_____
STATE TAX: (%)	$_____
TOTAL ESTIMATE	$_____

Form developed for inclosure to letter request for proposal from Contractor

Figure 4-4. Pacific Ocean Division, Corps of Engineers, fee proposal format.

additional forms they required for backup or detailed information for the proposal. One office--the 14th Coast Guard District--told us it did not have a printed fee proposal form and did not specify a particular proposal format for an architect-engineer firm to use.

Two offices--San Francisco Operations Office, Department of Energy, and Ames Research Center, National Aeronautics and Space Administration--used forms which were designed for research and development fee proposals. Department of Energy officials advised us that the form is used only as a cost summary and for the certifications which appear on the form. They said that the full proposal contains detailed cost data by task and subtask. All the other forms we saw were designed for architect-engineer services. While all call for basically the same information, each has its own characteristic. The forms run from simple--Goddard Space Flight Center--to detailed--Veterans Administration. Many firms complained that the Veterans Administration form was very difficult to work with.

Offices within the same agency do not always use the same forms. Ames Research Center of the National Aeronautics and Space Administration uses a standard printed form, whereas Goddard Space Flight Center has developed its own format and does not require firms to use a preprinted form. Within the Naval Facilities Engineering Command, we found three variations of the same basic form being used by the Atlantic, Pacific, and Western Divisions.

PREPRINTED FORMS NOT NECESSARY

Preprinted proposal forms force every proposal into the same form regardless of the nature of the project, instead of being tailored to the individual project. On the basis of what we observed, we question whether printed forms are necessary. Some agencies get along well without them. These agencies do, however, ask firms to use their fee proposal formats to facilitate comparing the firms' proposals with the Government's estimates.

The Corps of Engineers' Fort Worth District and Pacific Ocean Division do not use a preprinted form, except the pricing form required by procurement regulations when the anticipated fee will be over $100,000. These activities permit an architect-engineer firm to prepare its proposals on its own stationery. In the letter requesting a fee proposal, the district suggests the firm should use a certain format to facilitate the contract negotiations. This gives some

flexibility to the proposal. The National Park Service and Goddard Space Flight Center follow the same procedure these two districts use.

Officials from other agencies were concerned about differences between the architect-engineer's fee proposal and the Government's estimate. They felt that unless a standard form was used, they would not be able to compare the two figures. Responsible officials from the Corps of Engineers, the National Park Service, and Goddard all told us that this was not a problem because most firms followed the suggested format.

We believe that in many instances the figures are not comparable even when the same form is used. One of the reasons is the use of computer-aided methods. If the Government's estimate does not take into account the use of computer methods and the design firm's proposal does, it does not make any difference what form is used, since the figures for those areas where the computer is to be used are not comparable.

CHAPTER 5

COMPUTER USE AND COSTS SHOULD BE DISCUSSED THOROUGHLY DURING CONTRACT NEGOTIATIONS

The Federal agencies we surveyed have not given sufficient attention to the evolution of the computer as a major design tool when negotiating architect-engineer services contracts. The role of the computer in design is such that the planned use of this tool can be used as an aid in determining whether the design firm has a clear understanding of what the agency wants, especially when an energy analysis is required. Knowledge of planned uses of computer aids is also essential in determining whether the proposed fee is fair and reasonable. Many agency negotiators do not explore the design firm's planned uses of the computer. As a result, they do not necessarily insure that the architect-engineer firm has a clear understanding of the project requirements or that a fair and reasonable price is negotiated.

COMPUTERS NOT DISCUSSED

Generally, contract negotiators have not been exploring with the architect-engineer firm planned uses of computer-aided methods. The practices of negotiators vary from individual to individual, even within agencies. Individuals with a working knowledge and understanding about computer-aided techniques in design are more apt to routinely inquire about planned computer use on a project. However, as pointed out in chapter 3, many Federal officials had only limited knowledge about computer-aided design. Consequently, the subject was generally avoided unless the price of computer services became a problem in the negotiations.

CLEAR UNDERSTANDING OF PROJECT SCOPE NOT ALWAYS ACHIEVED

Agency heads are responsible for insuring that architects and engineers clearly understand the scope of work required and that a fair and reasonable price is negotiated. Architects, engineers, and agency officials all cited instances where the scope of the work required had been misunderstood.

Agency officials told us that, generally, discussions of scope received more emphasis than price during negotiations.

Apparently, both sides assume too much during these discussions which causes problems later. Discussing computer applications will not alleviate all of these problems. However, many of the situations we were made aware of could have been addressed and possibly averted had the planned use of computers been discussed thoroughly during contract negotiations.

For example, we were told about one project where a misunderstanding on the scope of the energy analysis was disclosed when the negotiator questioned the high cost of the analysis. The discussion of the computer costs made it clear that the firm did not have a good understanding of the work required. In this case, the problem was solved before bigger problems were caused. Had the matter slipped unnoticed through negotiations, delays would have occurred during design review, and the architect-engineer firm would have complained about the agency not knowing what it wanted and about having to redo the energy analysis and losing money.

Discussing the computer-aided techniques to be used for an energy analysis is very important. Several energy analysis programs are available, and more are being developed all the time. Not all of these programs have the same degree of sophistication, and their run costs vary widely. In addition to requiring an energy analysis, agencies should insure that the program the architect-engineer firm plans to use will provide the desired results. For example, if shading from adjacent structures should be considered in making the energy analysis, the agency should determine which energy program the architect-engineer firm plans to use. Not all energy programs have this capability. Some of the less costly, less sophisticated programs may be completely adequate for most projects. Still, for complex buildings, such as hospitals or laboratories, one of the more sophisticated, higher cost programs might lead to a more energy efficient design. The point is the agency should know what the architect-engineer firm is using for an energy analysis.

Discussions should also cover the full range of computer applications the architect-engineer firm plans to use. We believe these kinds of discussions will help create an environment much more conducive to the use of computer-aided techniques. In addition to establishing a clear understanding of project requirements, discussions will make it easier to reach an agreement on computer costs because both sides will have a better idea of how the computer will be used.

PRICING COMPUTER SERVICES

One of the most difficult elements in a fee proposal for Federal officials, both contract negotiators and auditors, to deal with is the reasonableness of the computer services costs. Many of the firms, which are heavy users of advanced computer techniques, complained about the attitude of Federal employees regarding these costs. Again the underlying problem is the apparent lack of understanding of how the computer is used and the sophistication and complexity of the intended use. We were told that many negotiators tried to evaluate computer costs based on experience gained during previous negotiations. If this is true, it is not an effective way to evaluate these costs. Many factors which affect these costs need to be considered in evaluating their reasonableness.

Negotiators need to know a couple of basic facts before evaluating the computer cost estimates. First, who will provide the services? Will the architect-engineer firm provide the services or are they to be procured from a service bureau? And, second, which pricing philosophy does the firm use? To our knowledge, the following six philosophies represent the current spectrum of computer pricing policies used by architect-engineer firms.

--No Direct Costs. All computer-related costs are considered basic operating expenses which are absorbed as part of the firm's overhead. As a result, the overhead rate generally increases so that all clients are indirectly charged for computer expenses whether or not they use the machine.

--Partial Costs. The client is charged only for those expenses which are directly related to the running of the job (generally equipment and operation related charges). All other charges, such as education, management, and primarily program development costs, are absorbed in the overhead.

--Total Costs. The client is charged for all readily isolated expenses so that the computer operation will run on a nearly break-even basis.

--Total Costs Plus Overhead. The client is charged for all expenses and an overhead allotment necessary to produce a break-even operation.

--Total Costs, Overhead, and Profit. The charge rate includes an allowance for overhead and profit in addition to recovering the basic costs.

--Value Pricing. The charge rate is based on the value of the product, mutually acceptable to the recipient and the provider of the service.

It is important to know which pricing philosophy a firm is using to determine whether its fee proposal is fair and reasonable. Federal Procurement Regulations paragraphs 1-15.202 and 1-15.203 outline the criteria for determining whether costs are direct or indirect. These paragraphs are worded in general terms and do not specifically mention computer services or computer costs.

Paragraph 1-15.202 (b) states that

"(b) Any direct cost of minor dollar amount may be treated as an indirect cost for reasons of practicality where the accounting treatment for such cost is consistently applied to all final cost objectives, Provided, that such treatment produces results which are substantially the same as the results which would have been obtained if such costs had been treated as a direct cost."

The interpretation of this provision has apparently created much of the confusion over whether computer costs are to be treated as overhead or direct costs. In the past, computer costs were minor dollar amounts, and they still are to some firms. However, as computer usage has grown, computer costs have become a significant cost item and are no longer considered minor by many firms. Nevertheless, some contract negotiators still will not accept computer services as direct costs and force firms to list these costs as an overhead item. This creates another problem because it causes firms to treat Government work differently than commercial work with respect to cost allocation. Federal agencies should not dictate how computer costs are to be handled because the appropriate treatment will not necessarily be identical for all firms. When looking at computer costs, negotiators should examine the computer pricing method used to insure that it meets the requirements of the Federal Procurement Regulations for proper treatment of these costs as direct or indirect. Arbitrary movement of computer costs by negotiators from direct to indirect, or vice versa, should be made only when necessary for compliance with procurement regulations.

CHAPTER 6

COMPUTER EXPERTISE SHOULD BE CONSIDERED WHEN SELECTING ARCHITECT-ENGINEER FIRMS

Federal policy requires that architects and engineers be selected on the basis of demonstrated competence and qualifications to do the work required. Federal agencies are increasingly requiring analytical techniques, such as energy analyses, solar studies, and life-cycle costing, which require the use of computers. Still, few agencies are considering and evaluating computer expertise when selecting an architect-engineer for a Federal project. In spite of the potential benefits which can be achieved through efficient use of computer-aided techniques, Federal agencies are not actively seeking this expertise in their selection process.

FEDERAL POLICY

Public Law 92-582, approved October 27, 1972, establishes that it is the policy of the Federal Government

> "* * * to negotiate contracts for architectural and engineering services on the basis of demonstrated competence and qualification for the type of professional services required * * *."

It is the intent of the Congress that the highest qualified architects and engineers be used for Federal design projects and related work. The wording of the law permits agencies to consider and evaluate computer expertise when contracting for architect-engineer services.

Some Federal officials feel that their agencies cannot actively encourage computer use and seek this expertise when selecting architect-engineer firms. They believe that to require or to encourage the use of computers and computer-aided techniques on Federal projects will discriminate against noncomputer users and small firms, including minority firms. We disagree with this position.

First, several Federal agencies are already requiring analyses, such as life-cycle costing, solar studies, and energy analysis, which can be done effectively only with computers. Second, this position assumes a direct relationship between size and a firm's ability to use in-house computer capability in order to get a contract.

The responses to our questionnaire show that firms of all sizes possess computer capability, including minority and small business firms. Many firms hire consultants to handle work steps, including computer analyses, which the firms cannot or do not have the expertise to handle in-house.

COMPUTERS NOT CONSIDERED IN EVALUATING QUALIFICATIONS

Federal agencies have developed their own criteria for evaluating the competence and qualifications of firms being considered for architect-engineer contracts. Most agencies have not yet incorporated skill and efficiency in using computer-aided techniques into these criteria. Some Federal officials told us they independently consider computer expertise, but do not assign a value to this factor in making an evaluation. It is used only as a tie-breaker factor. The General Services Administration may give credit for experience doing life-cycle costing, but makes no differentiation between manual and computer-aided methods.

The San Francisco Operations Office, Department of Energy, has made computer capability and expertise a selection evaluation criterion. The office evaluates a firm's experience using computer-aided techniques for energy analyses and assigns evaluation points. Also, during an interview, it asks a firm specific questions about its computer use and expertise. For example, on a Lawrence Livermore Laboratory project, it asked design firms the following:

--"Identify and discuss in detail, solar and energy conservation design experience and capability.

--"What, if any, computer program do you use for optimizing building envelope and mechanical systems for energy conservation?

--"Do you have in-house computer analysis capabilities for dynamic seismic design of multi-story buildings?"

Agency comments

This matter was discussed with each of the 11 Federal construction agencies we reviewed. All 11 agencies believed that it was not feasible to take a positive position and require computer use except for certain analyses, such as

energy analyses. However, at the exit conferences, none objected to making computer capability a selection criterion on jobs where computer use is required. Some officials suggested adding computer expertise to the list of factors routinely used in evaluating the qualifications of firms being considered for any architect-engineer services contract. Nevertheless, when official agency comments were received, both the General Services Administration and the U.S. Postal Service objected to our proposal to require computers for certain types of analyses, as discussed in chapter 8.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

Federal procurement policies do not appear to hamper or limit the use of computer-aided methods by architects and engineers awarded Federal design contracts. However, some agency procedures and the actions of Federal officials, do, in fact, frequently hamper and limit the effective use of computers on Federal projects. Officials from design firms and Federal agencies clearly said that Federal officials need to be educated about the computer and its role and uses in the design process. This is, in our opinion, the underlying cause for many of the problems we identified. In situations where both the agency and design firm personnel were knowledgeable about computers, they were able to resolve differences in a rational manner to the satisfaction of both parties.

The conclusions and recommendations presented below apply to all types of architect-engineer projects, not just to building design projects. We found that the problems discussed in the report were not peculiar to any particular type of project, but were applicable to all types on which computers can be used.

CONCLUSIONS

Computer capabilities should be considered in selecting design firms

It is Federal policy to hire the highest qualified architects and engineers to design and offer consultant services in carrying out Federal Government construction projects. Our computer-aided building design study shows that the Government can benefit from greater use of computers in design. We believe that Federal agencies can realize more of the potential benefits if they require that capabilities and expertise be considered and evaluated when selecting architects and engineers for Federal projects.

Computers should be required for some analyses

There are certain areas of the design process where computer applications are essential, and other areas where computer-aided methods can produce a better product. We believe Federal agencies should start requiring the use of computers where they are essential, such as for an energy

analysis, a seismic analysis, and life-cycle costing. We also believe that agencies should encourage greater use and development of computer methods which can improve the quality of the design products. Design firms should be encouraged to use these aids when they are available. In short, we believe that if firms have computer capabilities and can use them efficiently, firms should be encouraged to use them. However, because a firm has a computer does not mean that it can be used effectively or efficiently. A computer cannot be substituted for sound judgment. Consequently, computer expertise should be evaluated during the selection process, not during contract negotiations or as the project progresses.

An environment conducive to computer use needs to be created

Steps need to be taken to create an environment more conducive to computer use on Federal projects. Agency officials involved in architect-engineer selection, contract negotiations, project management, and design review need to be educated about the use of computers in design. They should be encouraged to learn more about the capabilities of computers in design through formal training, seminars, and conferences. Contract negotiators also need to be made aware of the computers' impact on operating costs of design firms. Further, procurement personnel involved in architect-engineer contract negotiations need to either (1) receive some training on design methods and computer use or (2) receive adequate technical support during negotiations so that contracts can be negotiated without limiting the use of computers.

Agencies should also examine their procedures and practices to identify where they may be inadvertently limiting or hampering the use of computer methods. We recognize that sometimes the use of computers is limited by factors over which the agency has no control, such as budgetary restraints on construction and the 6-percent statutory limitation on architect-engineer fees. However, we believe that even within these limitations, there are situations where a little more design money for computers will result in lower construction costs, lower future operating costs, or both. For example, many architect-engineer fees are negotiated well below the statutory limit. The limitation currently hampers the negotiation of a fair and reasonable fee for small projects (usually less than $500,000 estimated construction cost), renovations, and some innovative projects. Also, most agencies consider an energy analysis and life-cycle

costing to be outside the 6-percent limitation, and therefore, not restrained by the statute. Increasing the design budget by 17 percent is recovered if the resulting construction cost is reduced by 1 percent; not considering possible life-cycle cost benefits. Each situation must be evaluated on a case-by-case basis taking this potential into account.

Fee proposal format should be improved

The primary objectives of architect-engineer contract negotiations are to make sure the firm understands the scope of the project and to agree on a fair and reasonable price for the services to be provided. The key document in the negotiation is the fee proposal. We believe that the negotiation process would be improved if proposals recognized the use of computer aids and if proposals were presented in a task-oriented format. Some agencies are already using this format. We believe redirecting the emphasis of the fee proposal format to more clearly show the methods to be used and the services to be performed will assist contract negotiators more than formats currently used.

We believe greater fee proposal flexibility could be achieved by eliminating the preprinted forms and adopting such procedures as the Fort Worth District and Pacific Ocean Divisions of the Corps of Engineers and the National Park Service use. Some savings in administrative costs could also be realized from such action.

Classification of computer costs should be clarified

Most of the confusion that exists regarding how to show computer costs in the fee proposal could be eliminated if agencies were to provide architects and engineers some guidance on this topic. It would also help if agencies would insure that their personnel applied the existing and future regulations and guidance consistently throughout the agencies.

Computer use should be discussed during negotiations

It seems essential for an agency to fulfill its responsibilities to (1) make certain the architect-engineer firm has a clear understanding of the project requirements and (2) reach a mutual agreement on the provisions of the contract, including a fair and reasonable price, that officials must know how the design team plans to execute the work.

Many of the computer problems discussed by architect-engineer firms resulted from the lack of a clear understanding of what the agency wanted and/or what the design team planned to do. The planned computer-aided methods and programs to be used should be discussed, as well as matters, such as depth of analysis, number of alternatives to be considered, and rationale for using certain computer programs. These factors have a direct bearing on the architect-engineer firm's fee proposal and the reasonableness of the costs.

Government estimates should be prepared based on the architect-engineer firm's planned use of computer aids. Only in this way will the fee proposal and the Government estimate be truly comparable. In order to do this, a preliminary meeting with the selected firm is essential.

Other matters

The transfer of design information from an architect-engineer firm to an agency in machine readable form is a problem on the horizon. It is one which will need to be addressed soon by Federal agencies, possibly through the Federal Construction Council, because it will create big headaches for all concerned. Unless a standard infrastructure is developed for all Federal work, Federal practices will continue to inhibit the efficient use of computers. In addition, agencies will be prevented from realizing the possible benefits when building design descriptions and drawings are readily available on tape for use in facility management and other activities beyond the design and construction of a new facility.

RECOMMENDATIONS

We recommend that the heads of departments and agencies procuring architect-engineer services take the following actions:

1. Provide appropriate training--courses, seminars, newsletters, etc.--on the capabilities and uses of computers in design to their employees. Employees receiving this training should include those involved in selecting design firms, negotiating contracts, managing projects, and reviewing designs. This will increase employees' awareness of the computer and its use in design and enable them to more effectively and efficiently carry out their assigned responsibilities. Also, we recommend

that agencies and departments encourage employees to stay current on new and improved uses of computers in their individual areas of expertise.

2. Provide sufficient technical support to contract negotiating teams. This support should include personnel with sufficient knowledge about computer use and the related costs to enable teams to realistically evaluate the planned use of computer methods and negotiate a fair and reasonable fee for the services to be provided.

3. Direct that computer use be required for those analyses and design functions which can be done more efficiently and accurately by computer-aided methods and which are critical to the end product, in terms of safety, energy consumption, and life-cycle costs. Also, encourage computer use in all areas when the quality of the design or the structure to be built can be improved when computer aids are used.

4. Require computer capabilities and expertise to be considered and evaluated when selecting architects and engineers for projects on which computer-aided design methods, such as energy analyses, can be used. Also, revise the criteria used in evaluating the overall qualifications of firms for design contracts to include computer capability and expertise.

5. Require that architect-engineer contract negotiators routinely discuss and evaluate planned use of computers when negotiating design contracts.

We also recommend that the Administrator of the Office of Federal Procurement Policy with the concurrence of the Director of the Office of Management and Budget:

1. Promulgate an architect-engineer procurement policy which establishes that:

   a. Fee negotiations will be based on proposals which clearly identify tasks which will be performed by firms providing architect-engineer services, and when applicable, indicate how computers will be used on the project.

b. Procedures for pricing computer services will be flexible, as long as the method used is the same as the firm uses for all its clients, both public and private, and conforms with existing Federal Procurement Regulations.

c. A structured task-oriented fee proposal format will be developed and the use of preprinted fee proposal forms will be discontinued, permitting architect-engineer firms to submit their fee proposals in the prescribed structured format on their own stationery.

2. Require the Department of Defense and the General Services Administration to implement the new policy by revising the Defense Acquisition Regulations and the Federal Procurement Regulations, respectively, and jointly insuring that this policy is incorporated into the new Federal Acquisition Regulations currently being developed.

We further recommend that the Executive Secretary, Federal Construction Council, Building Research Advisory Board, direct the Council to take an active role in the training of the appropriate Federal personnel about the capabilities and uses of computers in design by

--pulling together the diverse information available on (1) the general use of computers in design, (2) existing computer-aided design tools and methods, and (3) advances in the state of the art of computer-aided design;

--developing the information into specific educational sessions for presentation to Federal personnel; and

--actively sponsoring these special educational sessions and other conferences.

CHAPTER 8

AGENCY COMMENTS

The agencies included in our review generally agreed, in principle, with the findings, conclusions, and recommendations presented in this report. However, some agencies disagreed with three of the recommendations. The General Services Administration and the U.S. Postal Service were opposed to requiring computer use for those analyses which could be efficiently done only by computer-aided methods. The General Services Administration opposed considering computer capabilities and expertise as a selection factor. The Postal Service and the Veterans Administration were opposed to eliminating the preprinted fee proposal forms currently used by most agencies.

COMMENTS RECEIVED

Five agencies--the Department of Energy, the U.S. Postal Service, the Department of State, the National Aeronautics and Space Administration, and the Office of Federal Procurement Policy--provided written comments on the draft report and one agency--the Department of Health and Human Services--gave us oral comments within the 30 days allowed by Public Law 96-226. The remaining agencies submitted their comments after the 30-day comment period, but before the report had been finalized. The written comments received were too voluminous to include all in the report. We have included the most significant and representative comments in appendixes IV through VII.

We also gave the Committee on Federal Procurement of Architectural/Engineering Services an opportunity to comment on the report. The committee, which is made up of the American Consulting Engineers Council, The American Institute of Architects, the American Road and Transportation Builders Association, the American Society of Civil Engineers, and the National Society of Professional Engineers, gave us oral comments. The committee indicated that it concurred with and fully supported our recommendations.

REQUIRE COMPUTER USE FOR CERTAIN ANALYSES

Both the General Services Administration (see app. IV) and the U.S. Postal Service (see app. V) were opposed to requiring that computers be used for those analyses which can be efficiently done only by computer-aided methods. Their comments imply that we are recommending that agencies should require the wholesale use of computers without regard to the

benefits which can reasonably be expected to be realized. Their interpretation is rather broad and is not consistent with the intent of our recommendation. Our recommendation is focused on those analyses which can be done more efficiently and accurately with a computer and which are critical to the end product in terms of safety, energy consumption, and life-cycle costs. The wording in our recommendation has been slightly revised to clarify its intent.

General Services Administration

The General Services Administration's objection was based primarily on its belief that the recommended action would require it to use computer methods regardless of the economic benefit. It states that "* * *the extent of computer-assisted methods should be a management decision based on carefully structured cost benefit analysis, not on mandatory provisions of the FPMR." We agree this would be preferable; however, neither the General Services Administration nor any of the other agencies included in the review have made such an analysis. The comments also state that "There are numerous projects where extensive use of computer-assisted designs are clearly not warranted." We also agree with this statement. In fact, this is the reason we are not recommending that agencies should require computer use in all aspects of a design project.

The General Services Administration's comments also indicate that it believes that cost effectiveness is a criterion for determining whether computer methods are warranted on a project. It implies that cost effectiveness is measured only in terms of reduced design costs. We believe that cost effectiveness should be measured in terms of potential for reduced construction costs, lower energy consumption, lower life-cycle costs, or other benefits, such as a more functional, barrier free design.

U.S. Postal Service

The Postal Service was opposed to this recommendation because it believed that design firms should decide if computer aids should be used or not. We agree with this statement, as a general rule. However, when economic benefits from the use of computers accrue to the Government, the decision to use or not should rest with the Government, and the use of the computer should be required. We believe that prudent management will require the use of any tool which will provide a cost benefit or reduce the risk of future liability or higher life-cycle costs.

Office of Federal Procurement Policy

The Office of Federal Procurement Policy (see app. VI) expressed some reservations about our recommendation requiring computer use. However, as the following statement shows, the office's belief is in line with what we are recommending.

> "Perhaps the Government should only require that necessary analyses be performed and not specify how they are to be accomplished, unless the method is critical to the end product." (Underscoring supplied.)

USE COMPUTER CAPABILITY AND EXPERTISE AS SELECTION FACTOR

The General Services Administration's objection was based primarily on its belief that the recommended action would discriminate against small architectural firms because "* * *these firms do not have available the necessary computer capability. This is borne out by the statistics contained in the draft report." This is an inaccurate statement. It is true that our statistical information does show that most architects do not use the computer. However, contrary to the General Services Administration's interpretation, it does not follow that computer capability is not available to small architectural firms.

The fact that architects choose not to use computers, preferring manual methods, has nothing to do with the availability of computer capabilities for the types of analyses in question. It is a common practice in building design for architectural firms to hire consulting engineers to do these types of analyses. Our questionnaire survey shows that most consulting engineers use computer-aided methods, therefore, one can conclude that computer capability necessary to perform these types of analyses is readily available from this source. Further, our recommendation does not say that agencies should require that the firm awarded the architect-engineer services contract have internal or in-house computer capabilities. In evaluating firms for a contract, the capabilities of the entire design team should be considered, not just those of the individual firms being considered for the contract award.

ELIMINATE PREPRINTED FEE PROPOSAL FORMS

The U.S. Postal Service (see app. V) and the Veterans Administration (see app. VII) objected to our recommendation to eliminate the use of preprinted fee proposal forms. Both agencies felt that the form was essential for making it easier to compare the design firm's fee proposal and the Government's estimate and to facilitate the preaward audit, when required.

Several agencies already operate without the use of preprinted fee proposal forms. The Veterans Administration and the Postal Service felt that eliminating the preprinted forms would require them to discard their fee proposal formats. While we believe their existing fee proposal formats need to be revised, we do not believe it would be wise to operate without some type of prescribed, structured fee proposal format. A printed form can still be used for the required certifications on those proposals which require preaward audits.

LIST OF FEDERAL ACTIVITIES

VISITED DURING OUR REVIEW

Corps of Engineers, U.S. Army
- Office of the Chief of Engineers, Washington, D.C.
- Fort Worth District, Fort Worth, Texas
- Pacific Ocean Division, Fort Shafter, Hawaii

Defense Contract Audit Agency, Department of Defense
- Honolulu Branch, Honolulu, Hawaii

Department of Energy
- Office of Construction and Facilities Management, Washington, D.C.
- San Francisco Operations Office, Oakland, California

Department of Health, Education, and Welfare (now the Department of Health and Human Services)
- Office of Facilities Engineering and Property Management, Washington, D.C.

Department of State
- Office of Foreign Buildings, Rosslyn, Virginia

National Aeronautics and Space Administration
- Office of Facilities, Washington, D.C.
- Ames Research Center, Moffett Field, California
- Goddard Space Flight Center, Greenbelt, Maryland

National Park Service, Department of the Interior
- Headquarters, Washington, D.C.
- Denver Service Center, Denver, Colorado

Naval Facilities Engineering Command, U.S. Navy
- Headquarters, Alexandria, Virginia
- Atlanta Division, Norfolk, Virginia
- Pacific Division, Makalapa, Hawaii
- Officer-in-Charge of Construction, Trident, Bremerton, Washington

Office of Federal Procurement Policy, Office of Management and Budget, Washington, D.C.

Public Buildings Service, General Services Administration, Headquarters, Washington, D.C.
- Region 7, Fort Worth, Texas
- Region 10, Auburn, Washington

U.S. Coast Guard, Department of Transportation
Headquarters, Washington, D.C.
14th District, Honolulu, Hawaii

U.S. Postal Service
Facilities Procurement Division, Washington, D.C.

Veterans Administration
Office of Construction, Washington, D.C.

APPENDIX II

PRIOR REPORTS AND STUDIES ISSUED BY THE GENERAL ACCOUNTING OFFICE SINCE JULY 1977 RELATING TO BUILDING DESIGN AND CONSTRUCTION

"Architect-Engineer Selection Process by the Corps of Engineers, Detroit District, of the Red Run Drain-Lower Clinton River, Flood Control Project," LCD-80-79, March 7, 1980.

"The Library of Congress' New Madison Building: Reasons For and Effects of, Delays and Escalating Costs," LCD-79-330, September 17, 1979.

"The Solar in Federal Buildings Demonstration Program," EMD-79-84, August 10, 1979.

"Renovation of House Office Building Annex No. 2 By the Architect of the Capitol," LCD-79-319, July 19, 1979.

"Recommendations of the Commission on Government Procurement: A Final Assessment," PSAD-79-80, May 31, 1979.

"Proposed Project to Renovate Nashville's Historic Train Station Building Needs to be Reevaluated," LCD-79-308, April 27, 1979.

"More Use Should Be Made of Energy-Saving Products in Federal Buildings," EMD-79-10, January 23, 1979.

"Minority Firms on Local Public Works Projects--Mixed Results," CED-79-9, January 16, 1979.

"Getting A Better Understanding of the Metric System--Implications If Adopted By the United States," CED-78-128 and 128A, October 20, 1978.

"General Services Administration Should Do More to Avoid Foundation Construction Problems," LCD-78-334, September 19, 1978.

"New Senate Office Building: Escalated Costs and Delayed Completion," LCD-78-333, August 14, 1978.

"The Department of State Has Continuing Problems in Managing Real Estate Overseas," ID-78-16, July 12, 1978.

"Computer-Aided Building Design," LCD-78-300, July 11, 1978.

"Questions Continue as to Prices in Contracting For Architectural-Engineering Services Under the Environmental Protection Agency Construction Grants Program," CED-78-94, June 6, 1978.

"Index of Construction Functions Performed by Federal Agencies," LCD-78-322, May 9, 1978.

"Military Construction Standards Should Be Updated To Better Meet User Needs and Save Money," LCD-77-351, April 3, 1978.

"Environmental Protection Agency's Construction Grant Program--Stronger Financial Controls Needed," CED-78-24, April 3, 1978.

"Information Relative to the Design and Construction of the New Federal Building in Williamsport, Pennsylvania," LCD-78-308, March 13, 1978.

"Questionable Practices of the Military Minor Construction Program," LCD-77-356, February 14, 1978.

"Improvements Needed in Department of Defense Energy Conservation Investment Program," EMD-78-15, January 18, 1978.

"Evaluation of the Plan to Conserve Energy in Federal Buildings Through Retrofit Programs," EMD-78-2, December 22, 1977.

"Use of New Construction Method on Federal Projects at Three Agencies Can Be Improved," LCD-77-348, October 26, 1977.

"General Services Administration's Use of New Construction Concept for Federal Buildings Not Yet Successful," LCD-77-322, October 6, 1977.

LIST OF FEE PROPOSAL FORMS USED BY AGENCIES INCLUDED IN OUR REVIEW

	Form	User Agencies
1.	DD Form 633-1 Contract Pricing Proposal (Technical Services)	Corps of Engineers, Naval Facilities Engineering Command, and the National Aeronautics and Space Administration
2.	NAVFAC 11012/2 (5-75) A&E Fee Proposal	Atlantic Division, Naval Facilities Engineering Command, and the Officer-in-Charge of Construction, Trident
3.	14ND PACDIV 04-11012/1 (3-76) A&E Fee Proposal	Pacific Division, Naval Facilities Engineering Command
4.	12ND WESTDIV 11012/1 (Rev. 6-78) A&E Fee Itemization	Western Division, Naval Facilities Engineering Command
5.	GSA Form 2630 (2-71) Architect-Engineer Cost Estimate	General Services Administration--all regions
6.	GSA Form 2631 (2-71) Architect-Engineer Cost Estimate Summary	General Services Administration--all regions
7.	Form FEC 4-17 (7-78) A/E Fee Proposal Breakdown	Department of Health and Human Services
8.	Form FEC 4-18 (7/78) A/E Fee Proposal Summary	Department of Health and Human Services
9.	VA Form 08-6298 (May 1976) Architect-Engineer Fee Proposal	Veterans Administration

10. Professional Services Estimate Work Sheets (No form number)	U.S. Postal Service
11. Schedule of Designated Services (No form number)	Department of State
12. Optional Form 60 (Research and Development)	San Francisco Operations Office, Department of Energy, and Ames Research Center, National Aeronautics and Space Administration
13. Architect-Engineer Cost Estimate (No form number)	Department of Energy (Optional form)

General Services Administration Washington, DC 20405

JUN 13 1980

Honorable Elmer B. Staats
Comptroller General of the United States
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Staats:

Thank you for the opportunity to review and comment on your draft report entitled "Agencies Should Change Procedures To Encourage Greater Computer Use on Federal Design Projects."

We have reviewed this draft report and generally concur in the desirability of using computer-assisted techniques in design and construction projects. However, the extent of computer-assisted methods should be a management decision based on carefully structured cost benefit analysis, not on mandatory provisions of the FPMR. There are numerous projects where extensive use of computer-assisted designs are clearly not warranted. We will continue to use and instruct our employees in the use of computers where they are determined to be cost effective.

We strongly oppose recommendation No. 4 since we believe that it would discriminate against the smaller architectural firms since these firms often do not have available the necessary computer capabilities. This is borne out by the statistics contained in the draft report.

Sincerely,

for R. G. Freeman III
Administrator

APPENDIX V

THE POSTMASTER GENERAL
Washington, DC 20260

May 29, 1980

Dear Mr. Voss:

This refers to your draft report to the Congress entitled "Agencies Should Change Procedures to Encourage Greater Computer Use on Federal Design Projects."

As requested, we have reviewed the final wording of the report's recommendations and are in agreement with it except:

A. Recommendations for heads of departments and agencies, pages v and vi of the Digest:

Recommendation 3: We do not recommend that Architect-Engineers be directed to use computers. We believe that the methods chosen to provide the required professional services should be the decision of the Architect-Engineer. (This is accomplished by clearly defining the scope of work and not prescribing the methods to be used by the Architect-Engineer to perform the work.)

Recommendation 4: We recommend that computer capabilities and expertise be included in the evaluation and selection of architects and engineers only when it is known that the use of computers would be more efficient or more cost effective than other methods. (See GAO note.)

Recommendation 5: We recommend that negotiators discuss and evaluate planned use of computers only when the services include analysis which can be efficiently done by computer-aided methods. (See GAO note.)

GAO note: Comments on recommendations 4 and 5 not discussed in report because the Postal Service did not state why it was suggesting the wording change.

APPENDIX V

B. Recommendations for Administrator, Office of Federal Policy, on pages vi and vii of the Digest:

Recommendation 1c: We recommend use of preprinted forms in order to provide a consistent format for review of fee proposals. However, we see no difficulty in adding space for the Architect-Engineer to note additional items. Such additional items could also be equally well accepted on the Architect-Engineer's letterhead.

Thank you for affording us this opportunity to offer comments.

Sincerely,

William F. Dolger

Mr. Allen R. Voss, Director
General Government Division
U.S. General Accounting Office
Washington, D.C. 20548

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

OFFICE OF FEDERAL PROCUREMENT POLICY

JUN 6 1980

Mr. J. H. Stolarow
Director, Procurement and Systems
Acquisition Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Stolarow:

This refers to your May 12, 1980 letter regarding the draft report entitled, "Agencies Should Change Procedures to Encourage Greater Computer Use on Federal Design Projects."

In reviewing the draft report, we found two areas of concern. The first area relates to whether the Government should dictate that an architect-engineer use a particular tool such as a computer. The selection of design tools as well as analytical and design techniques are decisions best made by the architect-engineer. Some architect-engineers may prefer to use computers; others may not. Perhaps the Government should only require that necessary analyses be performed and not specify how they are to be accomplished, unless the method is critical to the end product.

Our second concern relates to the recommendation at the bottom of page 71 of the report. The recommendation would require heads of agencies to submit their views on the final report to our office for consolidation and submission to Congress. Since the report contains several recommendations that are not procurement in nature, we suggest each agency submit its report directly to Congress. This would maintain compliance with Section 236 of the Legislative Reorganization Act of 1970 and with Section 6(g), P.L. 93-400, Office of Federal Procurement Policy Act. (See GAO note.)

While we consider the above concerns to be important, they should not be interpreted as reflecting our disagreement with the major thrust of the report. The report provides a good discussion of some very difficult issues. The basic issue, however, seems to pertain to the difficulty of maintaining a knowledgeable, qualified workforce in a highly technical profession during rapid state-of-the-art changes. This issue, of course, transcends procurement, but you may be assured of our careful consideration of each of your ultimate recommendations.

Thank you for referring the report for our review and comment.

Sincerely,

Karen Hastie Williams

Karen Hastie Williams
Administrator

GAO note: The recommendation referred to was deleted from the report. We agree that some of the recommendations are not procurement matters and therefore a consolidated report compiled by the Office of Federal Procurement Policy might not be appropriate.

APPENDIX VII

Office of the
Administrator
of Veterans Affairs

Washington, D.C. 20420

Veterans
Administration

JULY 2 - 1980

Mr. Gregory J. Ahart
Director, Human Resources Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Ahart:

Thank you for the opportunity to review the May 13, 1980 draft report, "Agencies Should Change Procedures to Encourage Greater Computer Use on Federal Design Projects," which states the use of computer-aided methods on Federal design projects is often limited or hampered by action of agency officials and agency procedures and practices. The report states that while significant benefits and savings are possible through computer aids, available computer capability is not always used on Federal design projects. The General Accounting Office (GAO) believes that changes in procedures would create an environment more conducive to greater and more efficient use of computer-aided methods.

The GAO recommends that the heads of departments and agencies procuring architect-engineer services take the following actions:

--Increase the knowledge employees have about computers by providing appropriate training on the capabilities and uses of computers in design. Employees receiving this training should include those involved in selecting design firms, negotiating contracts, managing projects, and reviewing designs. This would increase employee awareness of the computer and its use in design, enabling them to more effectively and efficiently carry out their assigned responsibilities. Also, we recommend that these employees be encouraged to stay current on new and improved uses of computers in their individual areas of expertise.

We generally agree with the recommendation that Government employees' knowledge and awareness of computer capabilities and its use in design be increased. The Veterans Administration (VA) Office of Construction is among the forerunners in the development and use of computer techniques in construction. VA employees, representing various construction specialties, who are familiar with advanced computer uses in design and construction, confer with the Architect-Engineers (A/E) during the pre-negotiation stage. A program is being developed to provide special uniform training to our negotiators who have a more general architectural or engineering background. This orientation can include the latest concepts and techniques involving computer use.

Mr. Gregory J. Ahart

--Provide sufficient technical support to contract negotiating teams. This support should include personnel with sufficient knowledge about computer use and the related costs to enable the team to realistically evaluate the planned use of computer methods and negotiate a fair and reasonable fee for the services to be provided.

As mentioned in the previous paragraph, the construction specialists in our Office of Construction are familiar with advanced computer uses in design and construction and provide adequate technical support.

--Direct that computer use be required for those analyses which can be efficiently done only by computer-aided methods and its use be encouraged in other areas when the quality of the design or the structure to be built can be improved when computer aids are used.

We have some reservations about this recommendation. Requiring the use of computers can be very judgmental on "when the quality of the design or the structure to be built can be improved when computer aids are used." Widely differing views exist on what can be done efficiently by a computer. As stated in the report, computer use is very widespread in the A/E profession, and A/E's are expected to use it when there are no efficient alternate means of accomplishing certain tasks. While computer use can minimize the potential for human error, a computer cannot substitute for sound judgment. (See GAO note.)

--Require computer capabilities and expertise to be considered and evaluated when selecting architects and engineers for projects requiring computer analysis, such as an energy analysis. Also, revise the criteria used in evaluating the overall qualifications of firms for design contracts to include factors for computer capability and expertise.

Essentially, we agree with this recommendation, and our evaluation criteria asks for "innovative approaches to production and design." This covers computer use and other advanced design and production methods such as special techniques considered more valuable than computer applications on certain projects. We do not believe that computer capability should be a general selection factor on all projects, as this recommendation suggests. There are other important procurement factors to be considered, such as allowing small, minority, or local firms, which may not have computer capabilities, to compete on Federal projects.

--require that architect-engineer contract negotiators routinely discuss and evaluate planned use of computers when negotiating design contracts.

GAO note: We did not discuss these reservations in the report because the Veterans Administration did not explain its reasons for having reservations.

APPENDIX VII

Mr. Gregory J. Ahart

We have no objections to negotiators routinely discussing computer use with A/E's. However, we do not believe that computer use is expected or necessary on every project, regardless of the size, type, or complexity.

We agree with the recommendation to the Administrator of the Office of Federal Procurement Policy that pricing methods of computer services be flexible. Many of the remarks of A/E's suggest that computer costs can be conveniently lumped together in a proposal. They may be appropriately classed as direct or indirect costs, depending upon the computer facility ownership, proposed computer operations, and accounting practices of the A/E firm. We suspect that many of the A/E's problems with charging for computer services resulted from either a lack of knowledge or misunderstanding of accounting considerations.

We strongly disagree with discontinuing preprinted forms based solely on the findings of this report. There are many factors which should be considered other than accounting difficulties with computer costs. Instead of eliminating forms, perhaps most forms should be revised and made more flexible.

We agree that increased awareness of the capabilities inherent in computer-aided design methods, by both the provider and user, should be encouraged and we appreciate the opportunity to comment on this report.

Sincerely,

MAX CLELAND
Administrator

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U.S. GOVERNMENT PRINTING OFFICE : 1980 - 341-043/319